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From: Travis Klingforth

Re: Stormwater Pollution Prevention Plan (SWPPP)
American Chemical Service (ACS) NPL Site
Griffith, Indiana

The following items are enclosed:

No. of Copies	Description
1	Stormwater Pollution Prevention Plan (SWPPP) for ACS NPL Site, Griffith, Indiana

These data are submitted:

- [ ] At your request
- [ ] For your approval
- [ ] For your review
- [ ] For your action
- [X] For your files
- [ ] For your information

cc: Todd Lewis - MWH
Pete Vagt - MWH
Rob Adams - MWH
File

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STORMWATER POLLUTION PREVENTION PLAN
FOR
CONSTRUCTION OF OFF-SITE AREA COVER

AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

Montgomery Watson File No. 2090601

Prepared For:

American Chemical Service NPL Site
RD/RA Executive Committee
Griffith, Indiana

Prepared By:

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May 2001
Revision 1

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Prepared For:

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RD/RA Executive Committee
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Prepared by: ______________________ 5/10/01
Robert A. Adams, P.E. Date
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Appendix A	Potential Best Management Practices (BMPs) (Source: U.S. EPA, *Storm Water Management For Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-006, September 1992.)+
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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

American Chemical Service, Inc. (ACS) is a 33-acre parcel of land, located in Griffith, Indiana, in the northwest corner of Indiana. It includes a currently active chemical manufacturing plant located at 420 South Colfax Avenue. The Site began reclaiming spent solvent in 1955 and continues to manufacture specialty chemicals. Based on the findings of an Remedial Investigation/Feasibility Study (RI/FS) and subsequent studies and groundwater sampling, four primary contaminant source areas have been identified at the Site: the On-Site Containment Area (ONCA), the Still Bottoms Pond Area (SBPA), the Off-Site Containment Area (OFCA) and the Kapica-Pazmey (K-P) Area. Identified contaminants of concern include volatile organic compounds ("VOCs") in the soil and groundwater and PCBs in the soil. This Site was placed on the National Priorities List (NPL) in 1984.

The work covered by this Stormwater Pollution Prevention Plan (SWPPP) includes the construction of a clay and geomembrane cover for the Off-Site Containment Area and Kapica-Pazmey Area, collectively known as the Off-Site Area. The proposed work involves an estimated area of disturbed soil of 12 acres. This SWPPP has been prepared to detail the actions that will be taken to prevent or reduce the potential migration of contaminants in stormwater runoff during construction activities. This work is anticipated to begin in May 2001 and extend through December 2003.

1.2 REGULATORY BACKGROUND

In 1972, the Federal Water Pollution Control Act, also referred to as the Clean Water Act (CWA), was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The 1987 amendments to the CWA established a framework for regulating municipal and industrial stormwater discharges under the NPDES program. On November 16, 1990, the United States Environmental Protection Agency (USEPA) published final regulations that establish requirements for stormwater permits. These USEPA regulatory changes require many industries and municipalities across the nation to apply for a NPDES permit for all stormwater discharges. In many cases, individual states have received NPDES permitting authority from the USEPA to write individual or general stormwater permits. These NPDES permits generally require dischargers to:

- Eliminate non-stormwater discharges (including illicit connections) to stormwater systems;
- Develop and implement an SWPPP; and,
- Perform monitoring of discharges to stormwater systems.

1.3 INDIANA GENERAL PERMIT

Administration of the federal NPDES wastewater discharge permit program has been delegated to the Indiana Department of Environmental Management (IDEM) by the USEPA. Two types of stormwater discharge permits are issued by IDEM: Indiana General Permit 327 IAC 15-6 (Rule 6) regulates stormwater discharges from areas associated with industrial activities and Indiana General Permit 327 IAC 15-5 (Rule 5) regulates stormwater discharges from areas associated with construction activities. The work detailed in this SWPPP is being conducted in accordance with a Consent Decree under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) between ___ and the USEPA. All work is being conducted at the direction of the USEPA and per 40 CFR §300.400(e) a general stormwater permit does not need to be obtained for this work, as normally required by 327 IAC 15-5. Although not required to meet the administrative permit requirement, work done at NPL sites must meet the substantive requirements of the Indiana General Stormwater Permit for Construction Sites. Therefore, a Notice of Intent (NOI) was submitted to the IDEM Department of Water Management, the USEPA Remedial Project Manager, and the IDEM Project Manager.

1.4 PURPOSE

As stated previously, this SWPPP has been prepared to describe the various actions that will be undertaken in the Off-Site Area at ACS to prevent the contamination of stormwater runoff during construction activities. The SWPPP has two major objectives: (1) to help identify potential sources of pollution that could affect the quality of construction site stormwater discharges; and (2) to describe and ensure the implementation of practices to reduce the potential discharge of pollutants in the construction site stormwater discharges.

One of the most important factors in developing a SWPPP is the evaluation of available alternatives for controlling the contamination of stormwater. These alternatives might include administrative actions, such as employee training or reporting and inspection procedures; nonstructural controls, such as good housekeeping practices; or structural alternatives, such as stormwater detention basins. In order to develop the most cost-effective plan, the various alternatives available must be considered for facilities individually, tailoring the SWPPP to the needs and requirements of the individual facility.

This SWPPP serves as the Erosion Control Plan and has been prepared to meet the objectives and requirements of Title 327 of the Indiana Administrative Code, Article 15, Rule 5 (327 IAC 15-5) to ensure that a carefully documented record is kept of the efforts to minimize the potential for stormwater contamination. This plan details general stormwater pollution prevention procedures as well as site-specific information and includes sections describing the location of the site, erosion and sediment controls, stormwater management and controls, and administrative procedures.

2.0 FACILITY DESCRIPTION

2.1 FACILITY LOCATION

ACS is located in the town of Griffith in Lake County, Indiana. The Site occupies a total of 33 acres. The Off-Site Area occupies 12 of those acres. The Off-Site Area is shown in detail in Figure C-2.

2.2 SITE DESCRIPTION

The Off-Site Area is located south of the ACS facility railroad tracks and encompasses the Off-Site Containment Area (OFCA) and the Kapica-Pazmey (K-P) building area. A large portion of the Off-Site Area is essentially a continuation of the Town of Griffith landfill. During the RI, installation of soil borings indicated contaminated areas in the central and southern portions of the Off-Site Area. The barrier wall construction, which included excavation of several hundred feet at the perimeter of the Off-Site Area, verified the landfilled nature of the area. During the Pretreatment Material Handling and Low Temperature Thermal Treatment (LTTT) Studies, the central Off-Site Area was found to contain deteriorated drum carcasses and parts. This area is also a significant source area on Site.

The Record of Decision (ROD, 1992) reported that the OFCA received wastes that included 20,000 to 30,000 punctured, crushed drums, general refuse, on-site incinerator ash, and a tank truck containing solidified residue for disposal. The Pretreatment/Materials Handling and LTTT Treatability Studies, October and December 1997, respectively indicates that up to 50,000 drums, predominantly crushed and non-intact, could be buried within the OFCA. The area adjacent to the OFCA to the west and south is contiguous with the City of Griffith Landfill and contains landfilled municipal solid wastes. The K-P property has impacted soil from direct disposal as a result of drum washing operations. PCBs were also detected in the OFCA and K-P Area. Because of the nature of waste placement in this area, the PCB contamination is likely not contiguous throughout the area. Concentrations of lead in excess of 500 ppm were detected between 3 and 10 deep feet in the K-P area and between 10 and 15 feet deep in the OFCA, both of which will be covered as part of the Final Remedy.

Part of the remediation action prescribed by the Final Remedy (August 1999) includes the installation of an engineered cover over the areas containing buried waste in order to contain and prevent direct contact with impacted soil and vapors. In addition, in-situ vapor extraction (ISVE) technology will be used to remove VOC contaminants in the OFCA and the K-P Area, where there is sufficient vadose zone to implement ISVE. The Final Remedy further states that the OFCA and the K-P Area will be covered with a low permeability cover material that will provide a surface seal for the ISVE system, reduce infiltration of rainwater, and prevent direct contact with exposure to contaminants and vapors from the contaminants in those areas. The initial cover layers will be installed as part of the start-up of the ISVE systems. Once the ISVE systems are in place and have been optimized, the final layers of the covers will be installed. The ISVE system will then continue to be applied to the OFCA and the K-P Area, until air vapor samples indicate that the applicable shut down criteria have been reached.

2.3 STORMWATER DRAINAGE SYSTEM

The cover was designed to minimize the distance surface water has to travel to be off of the cap. Drainage areas were determined based on the final grading plan for temporary cover of the Off-Site Area. Each area was then incorporated into the Technical Release-55 (TR-55) and analyzed to determine the peak storm flows for each area. Peak stormwater flows from a 100-year, 24-hour storm event for Griffith, Indiana were utilized for this analysis.

Figure C-3 shows the proposed Off-Site Containment Area Interim Cover Surface Contours to be established by the capping activity and the stormwater drainage system. A stormwater drainage collection pond is located at the northwest corner of the Off-Site Area. Perimeter channels will be constructed to receive stormwater runoff from the cover and direct it to the drainage pond. These channels are placed at locations on the cover to drain the stormwater off the cover in an efficient, controlled manner. The channels will be lined with erosion control matting to minimize erosion of the underlying soils.

The final contours of the Off-Site Area cap are provided on Figure C-8.

3.0 MATERIAL HANDLING PROCEDURES

3.1 MATERIALS INVENTORY

Significant materials that are present or are to be used at the facility during construction that may impact surface waters include fuels and hydraulic fluids. Both exist in the liquid state and will be utilized in the heavy equipment and staging area.

3.2 MATERIALS HANDLING AND MANAGEMENT PRACTICES

The types of wastes and materials expected to be encountered on the Off-Site Area include refuse, contaminated soil, debris, and construction and demolition rubble. Other wastes resulting from closure activities that will require handling and management include decontamination water, used Personal Protective Equipment (PPE), and disposable field equipment. All of these types of wastes are relatively stable and pose a minimal spill and discharge threat. Hazardous wastes encountered during closure activities will not be discharged to land, but will be segregated from the waste stream, characterized through laboratory analysis, and disposed of in a manner consistent with the Consent Decree and applicable work plans.

The types of spills that could potentially occur during construction include spillage of fluids such as oil and fuel from construction equipment. A spill kit will be prepared prior to the beginning of construction activities and will be kept on-site in the staging area to allow a quick response. At a minimum, the spill kit will include Department of Transportation (DOT)-approved drums, non-spark plastic shovels, brooms, absorbent material, Tyvek/Saranex overalls, face shields, chemical- and petroleum-resistant gloves, paper towels, garbage bags, rubber boots, an emergency eye wash kit, respirators and cartridges, and soap and water for decontamination activities. Table 1 addresses appropriate spill response procedures.

3.3 POTENTIAL AREAS FOR STORMWATER CONTAMINATION

Materials handling and management practices have been evaluated for potential contamination of stormwater. This potential exists whenever there is a possibility of materials exposure outdoors. Contamination potential exists in any of the categories listed below:

1. Material Transfer Operations;
2. Materials Storage
3. Materials Disposal Operations (i.e., Sanitation)
4. Chemical Application Areas
5. Potential Erosion Areas

6. Off-site Tracking
7. Non-stormwater Discharges

The possibilities for stormwater contamination from these activities or circumstances are described in detail below in order to develop a comprehensive inventory of circumstances to be evaluated at this facility.

3.3.1 Materials Transfer Operations

Whenever materials are transferred or relocated, there is a potential for loss or spillage. Liquid materials received in bulk are likely sources of small volume spills. Over time, the quantity of spilled material can accumulate and become a significant source for stormwater contamination. Similarly, dry materials received in bulk are also subject to dispersion or spilling. In short, unless these operations take place in completely enclosed areas with proper drainage, there is a potential for stormwater contamination whenever significant materials are transported or transferred in bulk.

3.3.2 Materials Storage

Materials storage locations are frequently sources of stormwater contamination. Uncovered or inadequately covered materials are directly exposed to stormwater and, depending on their composition, may be a significant source of contamination. Similarly, if materials storage locations are overstocked or improperly used, the potential exists for stormwater contamination, either because materials are no longer stored in a properly enclosed area, or because spillage due to improper handling and stacking of materials in an overcrowded space occurs. Bulk materials storage areas are susceptible to accidental spill or loss of materials if proper vehicle-prohibiting measures are not in place around the storage area. Finally, materials storage areas may require spill containment provisions. In addition to dikes or berms around liquid storage containment areas, the facility should have a written spill prevention and countermeasure plan that designates clear and specific actions to prevent stormwater contamination.

3.3.3 Materials Disposal Operations

As with materials storage, materials disposal operations and locations pose a potential threat for stormwater contamination. Dumpster areas should be clean. Storage units should be intact without obvious damage or leaks. All waste storage units should be covered to prevent exposure of the contained materials to rainfall. Liquid waste materials should be properly stored and managed, preferably in a diked or bermed area and under a roof. Finally, wash water from vehicle or equipment washing should be disposed of properly and not allowed to run into stormwater conveyances. Compliance with State of Indiana waste disposal requirements and local sewer ordinances should be maintained at all times.

3.3.4 Chemical Application Areas

Application of chemicals to outdoor locations may create a source of stormwater contamination. Chemicals that might be applied outdoors typically include fertilizers, pesticides, and herbicides. These materials are typically applied to vegetated areas to encourage rapid plant growth and reduce erosion. As with all compounds used outdoors, the possibility of a spill or improper materials disposal can create further sources of stormwater contamination.

3.3.5 Potential Erosion Areas

Excavation activities associated with the construction of this site will leave areas temporarily void of vegetative or other protective cover. These areas will potentially be subject to stormwater erosion. Stormwater erosion has the potential to not only damage the site and facility, but also to provide a significant source of stormwater contamination. If any areas of the site are eroded, it is likely they will continue to erode and provide a source of stormwater contamination until the area is repaired. Additionally, any damaged swales or other stormwater conveyances may soon become sites of erosion damage. Finally, areas subject to uncontrolled runoff may become eroded if proper controls are not implemented. An inventory of all such sites of existing erosion, damaged conveyances, and uncontrolled runoff should be performed on site and a determination made of the appropriate countermeasures. These will be documented in the Inspection Forms (See Appendix B for example form).

3.3.6 Off Site Tracking

Tracked or wheeled vehicles used to perform site construction activities may track soils off site if they leave the boundaries of the site without first having removed accumulated site soils removed from the vehicle. Vehicle washwater should be properly managed and not allowed to run into stormwater conveyances.

3.3.7 Non-stormwater Discharges

Discharges of non-stormwater into storm drainage systems can present a significant source of stormwater contamination and are illegal. Dewatering activities are common at construction sites, and many construction operations use sump pumps to remove rainwater accumulating in areas such as localized depressions and trenches. These discharges are not classified as non-stormwater discharges unless they become contaminated with pollutants released from spills or leaks. If contaminated stormwater or groundwater is pumped directly to the ground or to the stormwater conveyance system, the pollutants are in effect transported directly to surface waters. Non-stormwater discharges also can occur when materials or vehicles are washed or cleaned and the wash water is allowed to discharge to the ground.

4.0 STORMWATER MANAGEMENT AND CONTROLS

4.1 BEST MANAGEMENT PRACTICE (BMP) IMPLEMENTATION PLAN

Upon reviewing the potential pollutants associated with the Off-Site Area, taking into consideration such ideas as short- and long-term costs, level of potential risk, and maintenance, a list of best management practices (BMPs) was generated to reduce the risk of a pollutant occurrence. A description of activity specific BMPs that may apply to some activities at the site is included in Appendix A (U.S. EPA, September 1992). Table 2 summarizes both current and suggested BMPs for the Site based on planned activities. Table 3 gives descriptions of the BMPs selected for each potential contaminant within the Site.

The BMPs suitable for this facility are divided into three categories: administrative procedures, nonstructural control procedures, and structural control procedures. These three categories are detailed separately below.

4.1.1 Administrative Procedures

Site inspections are to be performed periodically by designated personnel. These inspections will cover the entire construction area and will include each individual work area and potential pollutant sources on site. The site inspections will be recorded on an ACS Off-Site Area SWPPP Inspection Form (included as Appendix B). Completed inspection forms should be dated, signed, and filed with the SWPPP. Careful materials inventories, recordkeeping, and internal reporting of activities should be maintained by designated personnel for actions related to the SWPPP. Preventive maintenance of equipment and vehicles will be practiced. Employee training is to be provided at least once prior to construction to all personnel dealing with potential stormwater pollutants, in an effort to reduce runoff contamination. In addition, employees will be trained to recognize potential or existing erosion control problems and apply appropriate BMPs in all operating units at the site.

4.1.2 Nonstructural Control Procedures

Visual inspections will be conducted after storm events during construction activities to identify the potential for erosion and to determine if existing erosion control measures are adequate. These visual inspections will be recorded on an Off-Site Area SWPPP Inspection Form and filed with the SWPPP. Equipment operators will exercise caution when dispensing fuel to the vehicles during refueling operations. A spill control kit, as discussed in Section 3 of this SWPPP, will be provided and periodically checked for an adequate supply of absorbent materials. Other sections of the landfill area will be examined for evidence of erosion.

4.1.3 Structural Control Procedures

The cover of the Off-Site Area will be constructed according to the specifications of the Agency-approved Final Remedy for the Site and the construction documents prepared by Montgomery Watson. Soil excavated from around the Off-Site Area will remain within the Off-Site Area. Structural control procedures involve installation of devices to divert flow, store flow, or limit runoff. Options for such controls include straw bale dikes, silt fences, earth dikes, brush barriers, drainage swales, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet and outlet protection, sediment traps, and sedimentation ponds. The following structural control practices will be implemented to minimize the transport of sediment off of the site.

4.1.3.1. Sedimentation Pond

A sedimentation pond will be constructed adjacent to the northwest border of the Off-Site Area as shown on Figure C-3 and detailed on Figure C-6. This pond will detain stormwater flow during peak storm events to allow sediment to settle out of the stormwater instead of flowing off the Site.

4.1.3.2. Silt Fencing

During construction, silt checks will be used in the drainage channels to control erosion and sediment transport. Stormwater that has come in contact with the debris in the landfill will be collected and sent to the on-site Groundwater Treatment Plant. Silt fence specifications and details are contained in Appendix F.

To control erosion and sediment transport from excavated soils stored on site, the stockpile and spoils pile areas will be surrounded with silt fence until the stockpiled material is placed into the appropriate areas.

4.1.3.3. Drainage Channels and Terraces

In accordance with the construction drawings for the Off-Site Area, various drainage channels will be constructed to direct stormwater runoff. The channels will be lined with mulch, netting, or geotextile matting. Suitable control devices, such as hay bales, silt fences, or mulching will be used in these channels during construction activities until vegetation has been established. Typical details for drainage channels are provided on Figure C-6.

5.0 ADMINISTRATIVE PROCEDURES

In order to keep track of process changes, BMPs, record keeping practices, and reporting requirements, an administrative system will be developed and implemented. Administrative procedures will address the topics of responsible parties, plan review, plan revision, reporting, and record keeping. Records will be kept of relevant and required information including inspections, significant spills, follow-up responses, and modifications of operations and maintenance activities. The Stormwater Pollution Prevention Committee (SWPPC) will oversee all administrative procedures.

5.1 STORMWATER POLLUTION PREVENTION COMMITTEE

A SWPPC responsible for overseeing the development, administration, and implementation of this plan for the construction of a cover for the Off-Site Area at ACS will consist of the individuals listed in Appendix C. A certification of their acceptance to these positions and responsibilities is shown in Appendix C.

In addition, inspectors assigned by the committee will be responsible for stormwater monitoring, if required, and for periodic inspections of the facility to ensure implementation of the SWPPP.

5.2 PLAN REVIEW

The SWPPP shall be reviewed periodically for modifications that significantly impact the potential for stormwater discharge. The responsible party will immediately revise and update the appropriate document. When information critical to the purpose of the document has changed, revisions will be made in accordance with plan revision procedures listed below in the Plan Revision section. Examples of changes that will require plan revision include:

- Changes in materials used on site;
- Changes in the materials handling procedures;
- Changes to the scope of the construction activities; and,
- Changes in management practices.

The plan review process will be recorded using the form in Appendix D and submitted to the appropriate record keeping personnel assigned by the committee.

Periodic inspections of the facility to ensure implementation of the SWPPP will be performed at least once per month and/or following each one-half inch or greater storm event. A copy of the inspection report (ACS Off-Site SWPPP Inspection Form) to be used during each inspection is kept in Appendix B. Only designated personnel chosen by the committee will be allowed to participate in the inspection process. Personnel that have been designated to be inspectors to ensure implementation of the SWPPP are listed in Appendix C.

The inspector should record the date, the weather conditions during the inspection and the number of days since the last rainfall. The approximate amount of the last rainfall (in inches) should also be documented. All areas inspected should be listed on the inspection form along with any evidence of erosion and/or spilled materials and the corrective action or maintenance required to remedy the problem. A follow up inspection to assess the success of the corrective action/maintenance should be conducted following completion of the activity.

After each inspection, a completed form will be signed and dated by the inspector and filed with the SWPPP site copy. This form will be utilized for recording inspections and for determining if any corrective actions need to be taken to ensure the purpose of the SWPPP is being met.

5.3 PLAN REVISION

The SWPPP should be amended within 14 calendar days whenever there is a change in construction, operation, or maintenance which may affect the discharge of significant quantities of pollutants to surface water. The SWPPP should also be amended if it is in violation of any conditions of the Indiana General Stormwater Permit Rule 5 (327 IAC 15-5), or has not achieved the general objectives of controlling pollutants in stormwater discharges. The SWPPP inspection form should be revised, if necessary, to reflect any changes in the SWPPP. In the event that a revision of the SWPPP is required, the following procedures represent a minimum level of effort based on changes in activity:

Changes in materials used on site:

- The materials inventory will be updated for all affected operations.
- The table of potential stormwater contamination sources will be updated.
- Material handling procedures will be changed if needed.
- The updated SWPPP and/or revisions will be prepared.

Changes in the materials handling procedures:

- Materials handling procedures will be changed.
- The updated SWPPP and/or revisions will be prepared.
- The table of potential stormwater contamination sources will be updated, if necessary.

Response to specific problems anticipated while conducting daily operations at the facility (e.g., spills):

- Materials handling procedures will be changed, if needed.
- BMPs and spill prevention plans will be updated, if necessary.
- The updated SWPPP and/or revisions will be prepared.
- The table of potential stormwater contamination sources will be updated, if necessary.

All revisions to the SWPPP or the ACS Off-Site Area SWPPP Inspection Form should be recorded on the revision log sheet provided as Appendix D.

5.4 REPORTING

Because the Site is a NPL Site and subject to U.S. EPA jurisdiction under CERCLA, adherence to reporting requirements set forth in 327 IAC 15-5 is not necessary. However, sufficient documentation should be maintained at the Site to demonstrate compliance with the substantive requirements of 327 IAC 15-5. The following is a list of reporting requirements that may be required for this facility:

- Spill Record and Corrective Actions Taken

The forms for this report are included in Appendix E.

The following is a list of actions that require a report and/or report form to be submitted to the appropriate on-site record keeping personnel assigned by the SWPPC. Each of these reports or forms should be filled out by the designated personnel responsible for the applicable objective and filed with the SWPPP:

- Certification of the SWPPC
- Any Revision to the SWPPP
- Change in Qualified Inspectors
- Inspection Checklist and Follow-Up Responses
- Report of Significant Spills

5.5 RECORD KEEPING

Records will be kept of all significant stormwater pollution events (e.g., spills, failure of BMPs, etc.), in-house inspections, follow-up responses to these inspections, and any significant changes in on-site activities. These records will be maintained on site with the SWPPP.

The following records should be kept on site:

1. SWPPP: The SWPPP should be filed on site for review by regulatory authorities or the public.

2. NOI: A copy of the Notice(s) of Intent should be filed with the SWPPP. Copies of any additional NOIs prepared as a result of additional operators becoming involved in the project should also be filed as they are generated.

3. Certifications: The certifications signed by an authorized representative of the general contractor and subcontractors should be filed with the SWPPP. Be sure to

obtain certification from all contractors who should be aware of the terms and requirements of the SWPPP.

4. Inspection reports: All inspection reports should be filed with the SWPPP as they are generated.

5. Maintenance reports: Reports should be made of regular and special maintenance activities performed on the site.

6. Other materials: Other materials relevant to 327 IAC 15-5, including spill reports, correspondence with regulatory authorities, and photographs should be maintained with the SWPPP.

7. NOT: A copy of the Notice of Termination for the NPDES permit should be kept. After the NOT is filed, the formal record keeping requirements of 327 IAC 15-5 end. However, the records must be maintained for a minimum of three years after the termination of the project.

Because either the U.S. EPA or IDEM may conduct facility inspections to verify that all elements of the SWPPP are accurate; all documents, reports, and forms should be maintained in an organized fashion at the Site as required by the SWPPP. Maintenance of these records and reporting information provides documentation of the efforts to implement the SWPPP, as well as the facility's compliance with 327 IAC 15-5.

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TABLES

TABLE 1

SPILL RESPONSE PROCEDURES

ACS Site, Griffith, Indiana

Type of Spill	Proposed BMPs or Recommended Actions
Spillage of construction equipment fluids (oils, hydraulic fluids, etc.)	Create a berm around the spill to contain the liquid
	For large amounts, pump into a container and store in staging area for disposal
	For small amounts, mix with surface soils in bermed area
	Add absorbents to capture remaining liquid
	Shovel mixed material into dump truck or empty 55-gallon drum to take to a disposal site approved by Montgomery Watson

TABLE 2

SUMMARY OF STORMWATER MANAGEMENT PROGRAM BEST MANAGEMENT PRACTICES (BMPs)

ACS Site, Griffith, Indiana

Administrative BMPs	Nonstructural BMPs	Structural Control BMPs
Site Inspection Records	Materials Handling	Secondary Containment
Employee Training	Visual Inspection	Flow Diversion
Internal Reporting	Physical Mitigation Cleanup	Detention Pond
Materials Inventory	Vehicle Positioning	Drainage System Improvements
Preventative Maintenance	Good Housekeeping	Use of Decontamination Pad for Vehicles
Record Keeping		
Spill Prevention/Control Plan		

TMK/ape
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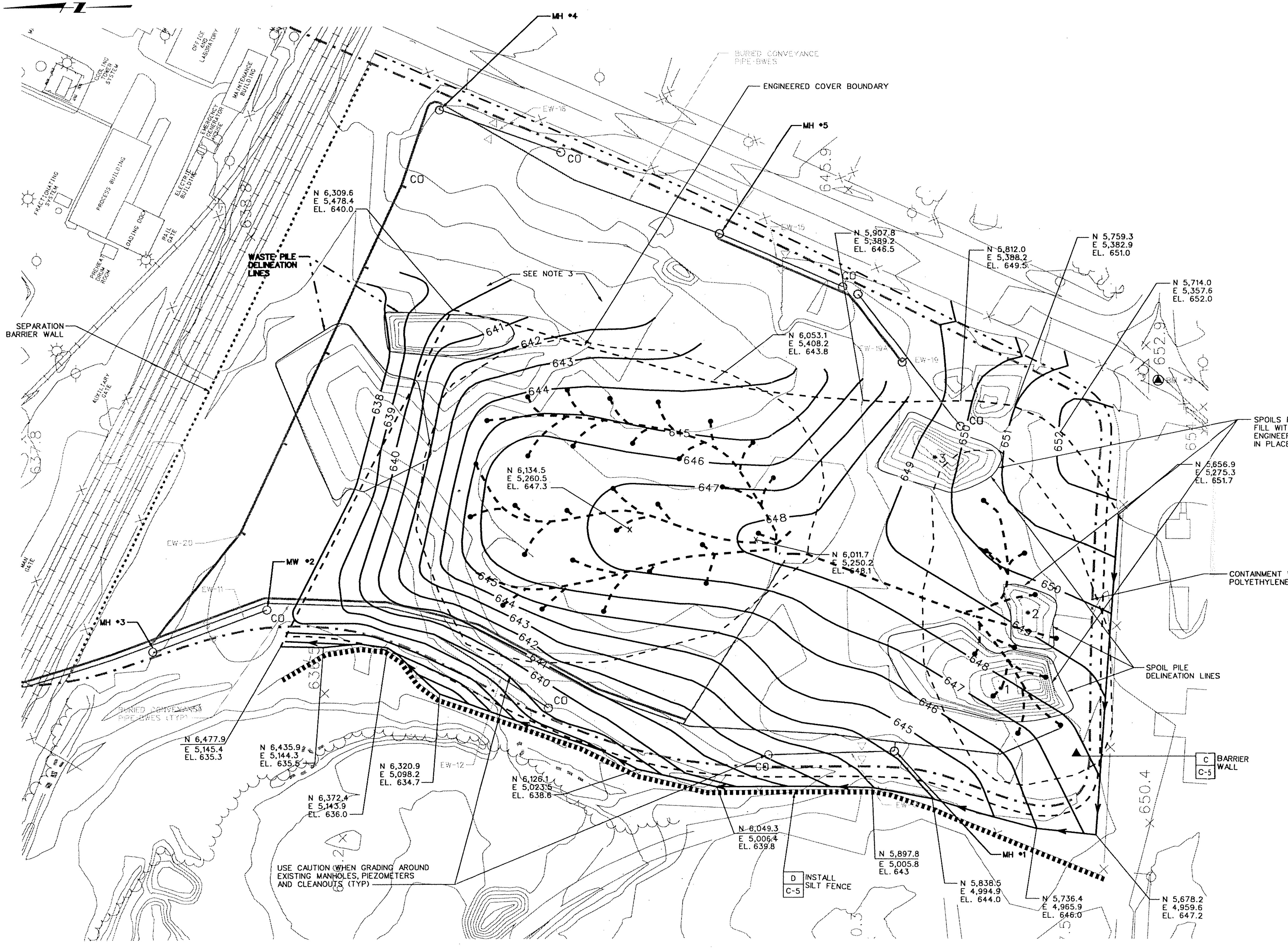
TABLE 3

DESCRIPTION OF PRIMARY BEST MANAGEMENT PRACTICES (BMPs) FOR POTENTIAL CONTAMINANTS

ACS Site, Griffith, Indiana

Potential Contaminants	Proposed BMPs or Recommended Actions
Sediment	Stabilization Practices: mulch matting, netting, or geotextile matting in drainage channels
	Structural Practices: Silt fencing, Sediment basin, Sediment traps
	Other Practices: Visual Inspection, Vehicle Washrack
	Frac Tanks (decon water)
Petroleum products (Oils, hydraulic fluids, etc.)	Materials Storage and handling practices (outlined in text of SWPPP)

FIGURES



LEGEND:

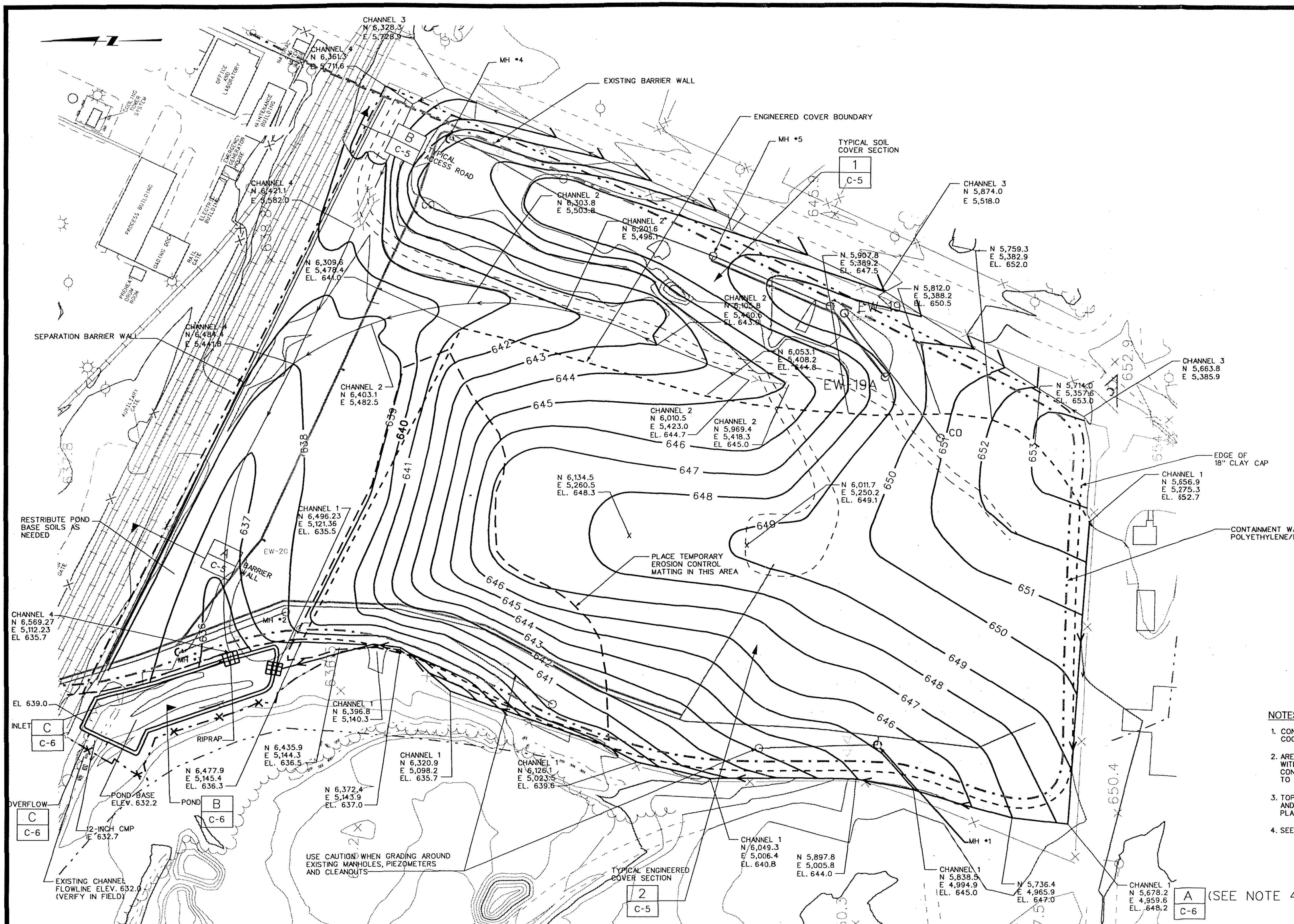
- EXISTING CONTOURS
- 640 — PROPOSED CONTOURS
- EXISTING PIEZOMETERS
- #1 — SPOILS PILES (3 TOTAL) TO BE RELOCATED WITHIN SUBGRADE LAYER
- WASTE PILES TO BE USED AS GENERAL FILL WITHIN SUBGRADE LAYER
- EXISTING/PROPOSED BWES TRENCHES
- CONTAINMENT BARRIER WALL
- SEPARATION BARRIER WALL
- FUTURE ISVE IMPLEMENTATION AREA (NOT IN THIS CONTRACT)
- DELINEATION OF OFCA ENGINEERED COVER (12-INCH CLAY AREA)
- LIMITS OF ISVE IMPLEMENTATION
- SILT FENCE
- DRAINAGE CHANNEL

NOTES:

1. CONTOURS SHOWN FOR GRAPHICAL REPRESENTATION ONLY. COORDINATES WILL GOVERN GRADING AND SURVEY LAYOUT.
2. SUBGRADE TO BE BLENDED INTO EXISTING SURFACE AT BOUNDARY.
3. REGRADE SPOIL PILE #1 WITHIN ISVE IMPLEMENTATION AREA.
4. DO NOT REGRADE SPOILS PILE #2 WITHIN AREAS OF ISVE IMPLEMENTATION
5. REGRADE SPOIL PILE #3 WITHIN THE OFCA ENGINEERED COVER.
6. DRUMS AND OTHER LARGE DEBRIS ARE TO BE PLACED WITHIN ENGINEERED COVER, BUT OUTSIDE SVE AREA.

Job No: MW Job # File: J:/209/0601 acs/0107 tem off site cover/drawing/civ/acs28c07_A.dgn Plot Date: 07-MAY-2001 11:15

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY					FIGURE
				1" = 50'-0"	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED TAB DRAWN RBA CHECKED	(PROJECT MANAGER) LICENSE NO. DATE (COMPANY OFFICER) LICENSE NO. DATE	MONTGOMERY WATSON Chicago, Illinois	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	OFF-SITE CONTAINMENT AREA SUBBASE CONTOURS		C-2



LEGEND:

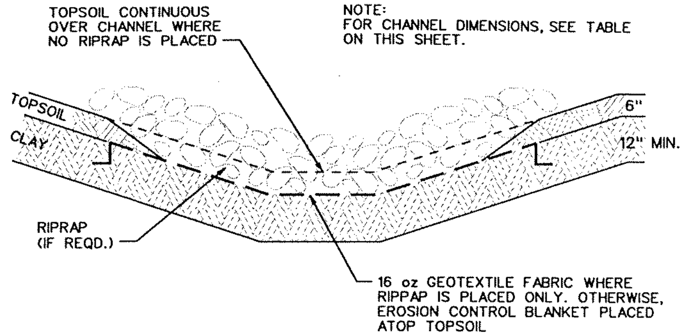
———	EXISTING CONTOURS
—640—	PROPOSED CONTOURS
△	EXISTING PIEZOMETERS
- - - -	TEMPORARY ACCESS ROAD
⊖———⊖	EXISTING BWES TRENCHES
—·—·—	SEPARATION BARRIER WALL
	CULVERT
———▸	DRAINAGE CHANNEL
—·—·—	EDGE OF 18" CLAY CAP
— — —	EROSION MATTING AREA
- - - -	EDGE OF ENGINEERING CAP
—×—	FENCE

NOTES:

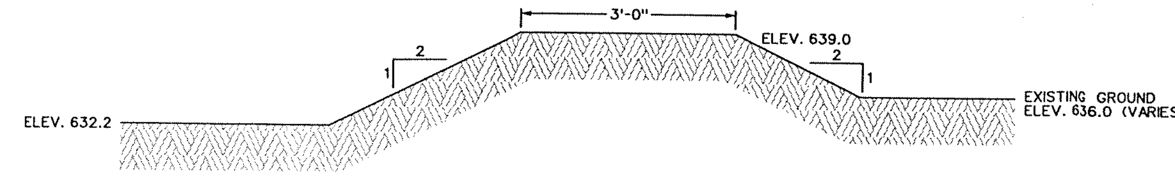
1. CONTOURS SHOWN FOR GRAPHICAL REPRESENTATION ONLY. COORDINATES WILL GOVERN GRADING AND SURVEY LAYOUT.
2. AREA OUTSIDE ENGINEERED COVER TO BE SUPPLEMENTED WITH CLAY SO THAT TOTAL CLAY THICKNESS IS 18". CONTOURS SHOWN FOR GRAPHICAL REPRESENTATION AND TO ILLUSTRATE DRAINAGE PATTERNS.
3. TOP OF CLAY TO BE SMOOTH AND FREE FROM SHARPS AND MATERIALS GREATER THAN 2" PRIOR TO FINAL FML PLACEMENT.
4. SEE FIGURE C-2 FOR SITE FENCE LOCATION.

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY						FIGURE
				1" = 50'-0"	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED TAB DRAWN RBA CHECKED	(PROJECT MANAGER) LICENSE NO. DATE (COMPANY OFFICER) LICENSE NO. DATE		MONTGOMERY WATSON Chicago, Illinois	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	OFF-SITE CONTAINMENT AREA INTERIM COVER SURFACE CONTOURS		C-3

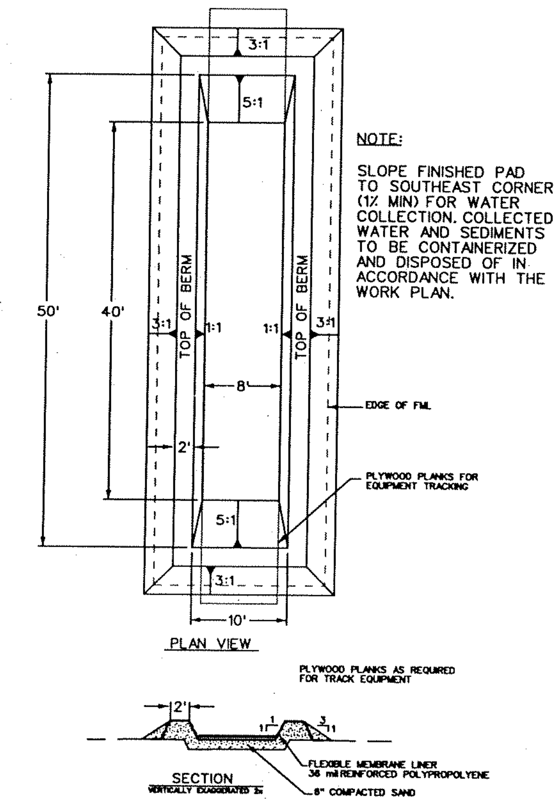
Job No: MW Job # File: J:/209/0601 acs/0107 tem off site cover/drawings/civ/acs28c08_c.dgn Plot Date: 07-MAY-2001 11:17



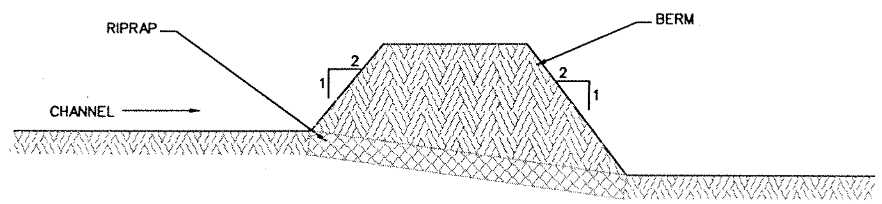
TYPICAL DRAINAGE CHANNEL A C-3
NOT TO SCALE



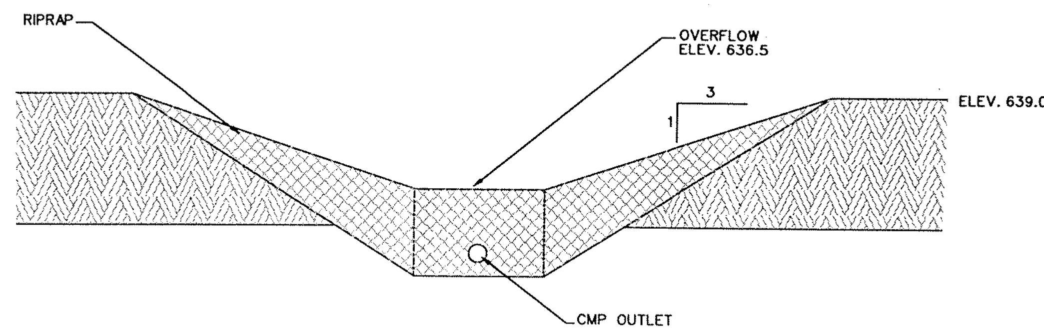
POND B C-3
NOT TO SCALE



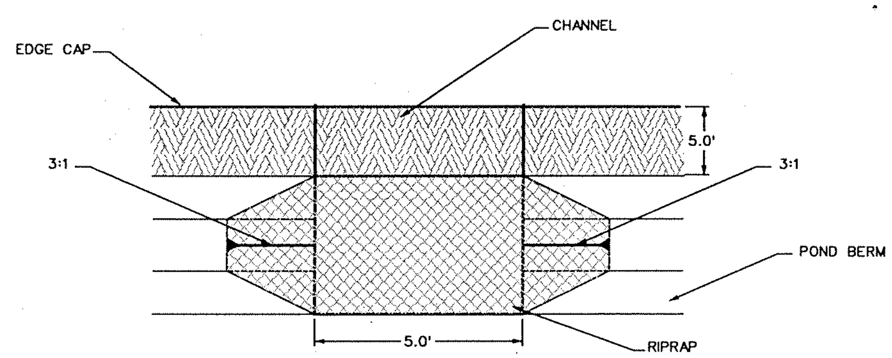
DECONTAMINATION PAD D -
NOT TO SCALE



INLET CROSS SECTION

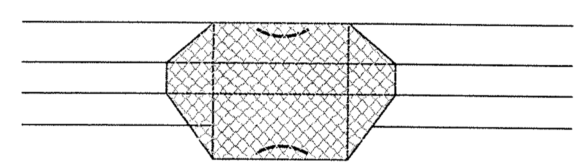


OUTLET PROFILE



INLET PLAN VIEW

INLET C C-3
NOT TO SCALE



OUTLET PLAN E C-3
NOT TO SCALE

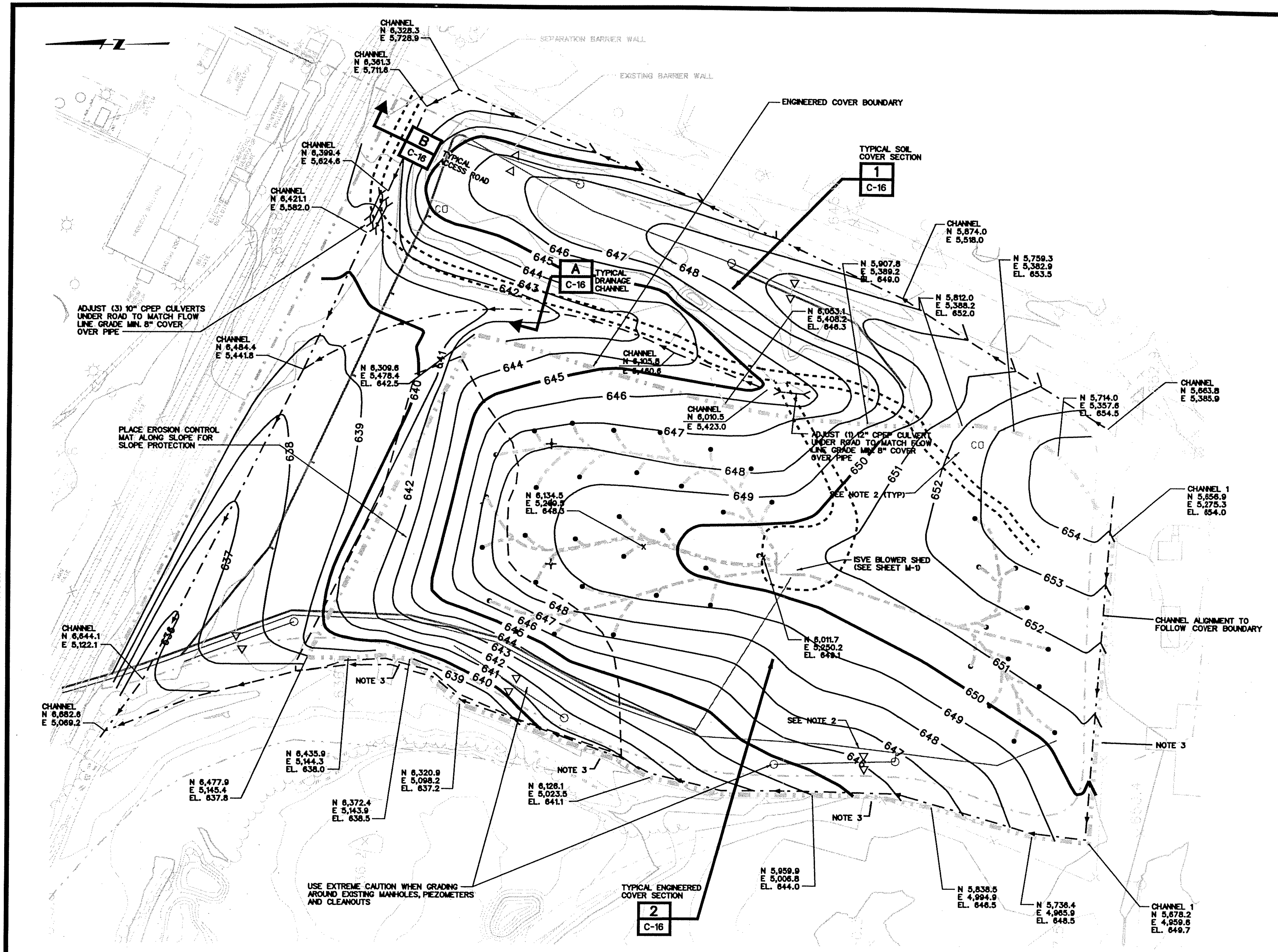
SUMMARY OF DATA RESULTS FOR DESIGNED TRAPEZOIDAL CHANNELS

CHANNEL NO.	DRAINAGE AREA	CHANNEL SLOPE	CHANNEL DEPTH	CHANNEL DIMENSIONS LEFT SIDE SLOPE	CHANNEL DIMENSIONS RIGHT SIDE SLOPE	CHANNEL BASE	CHANNEL VELOCITY	PEAK DISCHARGE ENTERING CHANNEL	MAXIMUM FLOW IN CHANNEL	MANNING'S COEFFICIENT
	(ACRES)	(FT/FT)	(FT)	H:V	H:V	(FT)	(FT/S)	(CFS)	(CFS)	---
1	4.25	0.015	1.0	4.0	4.0	2	4.10	13	24.58	0.035
2	3.31	0.015	1.0	4.0	4.0	2	4.25	14	25.48	0.030
3	1.78	0.019	1.0	4.0	4.0	2	4.10	7	24.58	0.035
4A	0.28	0.019	1.0	4.0	4.0	2	4.78	8	28.67	0.030
4B	2.36	0.019	1.0	4.0	4.0	2	5.44	31	47.59	0.030

TRAPEZOIDAL CHANNEL NOTES:
1) OFCA partitioned into six watershed sections
2) Channels 2, 4A and 4B Manning's Coefficient represents short grass and few weeds
3) Channels 1 and 3 Manning's Coefficient represents rock based on design section
4) Peak discharge entering channel based on 100 year, 24 hour storm event

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY			
				NONE	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED / DRAWN / CHECKED	(PROJECT MANAGER) LICENSE NO. DATE / (COMPANY OFFICER) LICENSE NO. DATE	MONTGOMERY WATSON Chicago, Illinois	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	SECTIONS AND DETAILS-OFCA	FIGURE C-6

Job No: MW Job # File: J:/209/0601 ACS/0107 ternoff site cover/drawing/cdt0042_b.dgn Plot Date: 07-MAY-2001 11:18



LEGEND:

640	PROPOSED CONTOURS
	EXISTING CONTOURS
△	EXISTING PIEZOMETERS
	ACCESS ROAD
	EXISTING BWES TRENCHES
	SEPARATION BARRIER WALL
•	ISVE WELL LOCATION
	DRAINAGE CHANNEL CENTER LINE

NOTES:

1. ALL DRAINAGE CHANNELS TO BE LINED WITH EROSION CONTROL MAT. SEE DETAIL A , SHEET C-16.
2. ALL MANHOLES, CLEANOUTS TO BE RAISED TO MATCH FINAL GRADE PLUS 6". PIEZOMETERS TO BE RAISED TO MATCH FINAL GRADE PLUS 30".
3. TOP OF OFCA ENGINEERED COVER EDGE WILL BLEND WITH EXISTING CONTOURS.

Job No: MW Job #

File: J:/1252/042/28/civ/acs28c09.dgn

Plot Date: 07-MAY-2001 11:20

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY					FIGURE
				1" = 50'-0"	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED TAB DRAWN RBA CHECKED	(PROJECT MANAGER) LICENSE NO. DATE (COMPANY OFFICER) LICENSE NO. DATE	MONTGOMERY WATSON Chicago, Illinois	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	OFF-SITE CONTAINMENT AREA COVER CONTOURS AND STORM WATER CONTROL		C-8

APPENDIX A

POTENTIAL BEST MANAGEMENT PRACTICES

CHAPTER 3

ACTIVITY-SPECIFIC SOURCE CONTROL BMPs

This chapter describes specific BMPs for common industrial activities that may contaminate storm water. Chapter 2 led you through the steps of identifying activities at your facility that can contaminate storm water. At this point, you should be ready to choose the BMPs that best fill your facility's need. You should read this chapter if any of the activities listed below take place at your facility. BMPs for each of these activities are provided in the sections listed below:

Activity	Section
Fueling	3.1
Maintaining Vehicles and Equipment	3.2
Painting Vehicles and Equipment	3.3
Washing Vehicles and Equipment	3.4
Loading and Unloading Materials	3.5
Liquid Storage in Above-Ground Tanks	3.6
Industrial Waste Management and Outside Manufacturing	3.7
Outside Storage of Raw Materials, By-Products, or Finished Products	3.8
Salt Storage	3.9

Each section is presented in a question and answer format. By answering these questions, you will be able to quickly identify source controls or recycling BMPs that are suitable for your facility. The BMPs suggested are relatively easy to use, are inexpensive, and often are effective in removing the source of storm water contaminants. This is not a complete list of BMPs for every industrial activity; rather, it is meant to help you think about ways you can reduce storm water contamination on your site. You may want to contact one of the State or Federal pollution prevention assistance offices listed in Appendix D for suggestions or help in choosing or using these and other BMP options.

3.1 BMPs FOR FUELING STATIONS

When storm water mixes with fuel spilled or leaked onto the ground, it becomes polluted with chemicals that are harmful to humans and to fish and wildlife. The following questions will help you identify activities that can contaminate storm water and suggest BMPs to reduce or eliminate storm water contamination from fueling stations. Read this section if your facility has outdoor fueling operations or if fueling occurs in areas where leaks or spills could contaminate storm water. Also refer to the BMPs listed in Section 4.2 on Exposure Minimization.

FUEL STATION ACTIVITIES THAT CAN CONTAMINATE STORM WATER:

- Spills and leaks that happen during fuel or oil delivery
- Spills caused by "topping off" fuel tanks
- Allowing rainfall on the fuel area or storm water to run onto the fuel area
- Hosing or washing down the fuel area
- Leaking storage tanks

Q. Have you installed spill and overfill prevention equipment?

Fuel overflows during storage tank filling are a major source of spills. Overflows can be prevented. Watch the transfer constantly to prevent overfilling and spilling. Overfill prevention equipment automatically shuts off flow, restricts flow, or sounds an alarm when the tank is almost full. Federal regulations require overfill prevention equipment on all Underground Storage Tanks (USTs) installed after December 1988. For USTs installed before December 1988, overfill prevention equipment is required by 1998. State or local regulations may be stricter, so contact your State and/or local government for details. Consider installing overflow prevention equipment sooner than the required deadline as part of your pollution prevention plan.

Q. Are vehicle fuel tanks often "topped off"?

Gas pumps automatically shut off when the vehicle fuel tank is almost full to prevent spills. Trying to completely fill the tanks or topping off the tank often results in overfilling the tank and spilling fuel. Discourage topping off by training employees and posting signs.

Q. Have you taken steps to protect fueling areas from rain?

Fueling areas can be designed to minimize spills, leaks, and incidental losses of fuel, such as vapor loss, from coming into contact with rain water:

- Build a roof over the fuel area.

- Pave the fuel area with concrete instead of asphalt. Asphalt soaks up fuel or can be slowly dissolved by fuel, engine fluids, and other organic liquids. Over time, the asphalt itself can become a source of storm water contamination.

Q. Is runon to the fueling area minimized?

Runon is storm water generated from other areas that flows or "runs on" to your property or site. Runon flowing across fueling areas can wash contaminants into storm drains. Runon can be minimized by:

- Grading, berming, or curbing the area around the fuel site to direct runon away from the fuel area
- Locating roof downspouts so storm water is directed away from fueling areas
- Using valley gutters to route storm water around fueling area.

Q. Are oil/water separators or oil and grease traps installed in storm drains in the fueling area?

Oil/water separators and oil and grease traps are devices that reduce the amount of oil entering storm drains. These devices should be installed and routinely inspected, cleaned, and maintained.

Q. Is the fueling area cleaned by hosing or washing?

Cleaning the fueling area with running water should be avoided because the wash water will pick up fuel, oil, and grease and make it storm water. Consider using a damp cloth on the pumps and a damp mop on the pavement rather than a hose. Check with your local sewer authority about any treatment required before discharging the mop water or wash water to the sanitary sewer.

Q. Do you control petroleum spills?

Spills should be controlled immediately. Small spills can be contained using sorbent material such as kitty litter, straw, or sawdust. Do not wash petroleum spills into the storm drain or sanitary sewer. For more information on spill control measures, see sections on Containment Diking and Curbing in Chapter 4.

Q. Are employees aware of ways to reduce contamination of storm water at fueling stations?

Storm water contamination from fueling operations often occurs from small actions such as topping off fuel tanks, dripping engine fluids, and hosing down fuel areas. Inform employees about ways to eliminate or reduce storm water contamination.

EMPLOYEE INVOLVEMENT IS THE KEY:

Getting employees interested in reducing waste generation is the key to a successful storm water pollution prevention plan. Discuss pollution prevention with your employees. They are most familiar with the operations that generate wastes and may have helpful waste reduction suggestions. Consider setting up an employee reward program to promote pollution prevention.

Q. Where does the water drain from your fueling area?

In many cases, wash water and storm water in fueling areas drain directly to the storm sewer without adequate treatment. Some types of oil/water separators installed at these locations can provide treatment to discharges from oil contaminated pavements, but this equipment is only effective when properly maintained (i.e., cleaned frequently). Some States require that these discharges be tied in to a sanitary sewer system or process wastewater treatment system. If discharges from fueling or other high risk areas at your facility drain to a sanitary sewer system, you should inform your local POTW.

SUMMARY OF FUELING STATION BMPs
• Consider installing spill and overflow protection.
• Discourage topping off of fuel tanks.
• Reduce exposure of the fuel area to storm water.
• Use dry cleanup methods for the fuel area.
• Use proper petroleum spill control.
• Encourage employee participation.

3.2 BMPs FOR VEHICLE AND EQUIPMENT MAINTENANCE

Many vehicle and equipment maintenance operations use materials or create wastes that are harmful to humans and the environment. Storm water runoff from areas where these activities occur can become polluted by a variety of contaminants such as solvents and degreasing products, waste automotive fluids, oils and greases, acids, and caustic wastes. These and other harmful substances in storm water can enter water bodies through storm drains or through small streams where they can harm fish and wildlife.

The following questions will help you find sources of storm water contamination from vehicle and equipment maintenance operations on your site and to help you choose BMPs that can reduce or eliminate these sources.

ACTIVITIES THAT CAN CONTAMINATE STORM WATER:

Engine repair and service:

- Parts cleaning
- Shop cleanup
- Spilled fuel, oil, or other materials
- Replacement of fluids (oil, oil filters, hydraulic fluids, transmission fluid, and radiator fluids)

Outdoor vehicle and equipment storage and parking:

- Dripping engine and automotive fluids from parked vehicles and equipment

Disposal of materials or process wastes:

- Greasy rags
- Oil filters
- Air filters
- Batteries
- Spent coolant, degreasers, etc.

Q. Are parts cleaned at your facility?

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners whenever possible reduces waste. Scrape parts with a wire brush, or use a bake oven if one is available. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. If you dip parts in liquid, remove them slowly to avoid spills. Locate drip pans, drain boards, and drying racks to direct drips back into a sink or fluid holding tank for reuse.

Q. Have you looked into using nontoxic or less toxic cleaners or solvents?

If possible, eliminate or reduce the number or amount of hazardous materials and waste by substituting nonhazardous or less hazardous materials. For example:

- Use noncaustic detergents instead of caustic cleaning agents for parts cleaning (ask your supplier about alternative cleaning agents).
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sanitary sewer. Contact your local sewer authority for more information.
- Replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with nonchlorinated solvents. Nonchlorinated solvents like kerosene or mineral spirits are less

toxic and less expensive to dispose of but are by no means harmless themselves. Check the list of active ingredients to see whether it contains chlorinated solvents.

- Choose cleaning agents that can be recycled.

Contact your supplier or trade journal for more waste minimization ideas.

Q. Are work areas and spills washed or hosed down with water?

Clean up leaks, drips, and other spills without large amounts of water. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Consider the following BMPs:

- Avoid hosing down your work areas.
- Collect leaking or dripping fluids in drip pans or containers. If different liquids are kept separate, the fluids are easier to recycle.
- Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Locate waste and recycling drums in properly controlled areas of the yard, preferably areas with a concrete slab and secondary containment.

Q. Are spills or materials washed or poured down the drain?

Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections. Used or leftover cleaning solutions, solvents, and automotive fluids and oil are often toxic and should not be put into the sanitary sewer. Be sure to dispose of these materials properly or find opportunities for reuse and recycling. If you are unsure of how to dispose of chemical wastes, contact your State hazardous waste management agency or the RCRA hotline at 1-800- 424-9346. Post signs at sinks to remind employees, and paint stencils at outdoor drains to tell customers and others not to pour wastes down drains.

Q. Are oil filters completely drained before recycling or disposal?

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over the waste oil recycling or disposal collection tank to drain excess oil before disposal. Oil filters can be crushed and recycled. Ask your oil supplier or recycler about recycling oil filters.

Q. Are incoming vehicles and equipment checked for leaking oil and fluids?

If possible, park vehicles indoors or under a roof so storm water does not contact the area. If you park vehicles outdoors while they await repair, watch them closely for leaks.

Put pans under leaks to collect fluids for proper recycling or disposal. Keeping leaks off the ground reduces the potential for storm water contamination and reduces cleanup time and costs. If the vehicle or equipment is to be stored outdoors, oil and other fluids should be drained first.

Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer and drips and spills can be easily cleaned up.

Q. Are wrecked vehicles or damaged equipment stored onsite?

Be especially careful with *wrecked vehicles*, whether you keep them indoors or out, as well as with vehicles kept onsite for scrap or salvage. Wrecked or damaged vehicles often drip oil and other fluids for several days.

- As the vehicles arrive, place drip pans under them immediately, even if you believe that all fluids have leaked out before the car reaches your shop.
- Build a shed or temporary roof over areas where you park cars awaiting repairs or salvage, especially if you handle wrecked vehicles. Build a roof over vehicles you keep for parts.
- Drain all fluids, including air conditioner coolant, from wrecked vehicles and "parts" cars. Also drain engines, transmissions, and other used parts.
- Store cracked batteries in a nonleaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

BATTERY ACID SPILLS:

Handle spilled acid from broken batteries with care. If you use baking soda to neutralize spilled acid during cleanup, remember that the residue is still dangerous to handle and must be disposed of as a hazardous waste because it may contain lead and other contaminants.

Q. Do you recycle any of these materials?

- Degreasers
- Used oil or oil filters
- Antifreeze
- Cleaning solutions
- Automotive batteries
- Hydraulic fluid.

All of these materials can be either recycled at your facility or sent offsite for recycling. Some recycling options, ranked by level of effort required, follow.

Least Effort:
• Arrange for collection and transportation of car batteries, used oil and other fluids, cleaning solutions, and degreasers to a commercial recycling facility. This requires that you separate wastes and store them until they are picked up by the recycling company. • "Dirty" solvent can be reused. Presoak dirty parts in used solvent before cleaning the parts in fresh solvent.
Moderate Effort:
• Used oil, antifreeze, and cleaning solutions can be recycled onsite using a filtration system that removes impurities and allows the fluid to be reused. Filtration systems are commercially available.
Most Effort:
• Install an onsite solvent recovery unit. If your facility creates large volumes of used solvents, you may consider purchasing or leasing an onsite still to recover the solvent for reuse. Contact your State hazardous waste management agency for more information about onsite recycling of used solvents.

Q. Can you reduce the number of different solvents used?

Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents.

EMPLOYEE INVOLVEMENT IS THE KEY:

Getting employees interested in reducing waste generation is the key to a successful storm water pollution prevention plan. Discuss pollution prevention with your employees. They are most familiar with the operations that generate wastes and may have helpful waste reduction suggestions. Consider setting up an employee reward program to promote pollution prevention.

Q. Are wastes separated?

Separating wastes allows for easier recycling and may reduce treatment costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from nonchlorinated solvents (like kerosene and mineral spirits). Proper labeling of all wastes and materials will help accomplish this goal (see Signs and Labels BMP).

Q. Do you use recycled products?

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

SUMMARY OF VEHICLE MAINTENANCE AND REPAIR BMPs
• Check for leaking oil and fluids. • Use nontoxic or low-toxicity materials. • Drain oil filters before disposal or recycling. • Don't pour liquid waste down drains. • Recycle engine fluids and batteries. • Segregate and label wastes. • Buy recycled products.

3.3 BMPs FOR PAINTING OPERATIONS

Many painting operations use materials or create wastes that are harmful to humans and the environment. Storm water runoff from areas where these activities occur can become polluted by a variety of contaminants such as solvents and dusts from sanding and grinding that contain toxic metals like cadmium and mercury. These and other potentially harmful substances in storm water can enter water bodies directly through storm drains where they can harm fish and wildlife.

The following questions will help you identify potential sources of storm water contamination from painting operations on your site and BMPs that can reduce or eliminate these sources. Reading this section can help you eliminate, reduce, or recycle pollutants that may otherwise contaminate storm water.

PAINTING ACTIVITIES THAT CAN CONTAMINATE STORM WATER:
• Painting and paint removal
• Sanding or paint stripping
• Spilled paint or paint thinner

Q. Is care taken to prevent paint wastes from contaminating storm water runoff?

Use tarps and vacuums to collect solid wastes produced by sanding or painting. Tarps, drip pans, or other spill collection devices should be used to collect spills of paints, solvents, or other liquid materials. These wastes should be disposed of properly to keep them from contaminating storm water.

Q. Are wastes from sanding contained?

Prevent paint chips from coming into contact with storm water. Paint chips may contain hazardous metallic pigments or biocides. You can reduce contamination of storm water with paint dust and chips from sanding by the following practices:

- Avoid sanding in windy weather when possible.
- Enclose outdoor sanding areas with tarps or plastic sheeting. Be sure to provide adequate ventilation and personal safety equipment. After sanding is complete, collect the waste and dispose of it properly.
- Keep workshops clean of debris and grit so that the wind will not carry any waste into areas where it can contaminate storm water.
- Move the activity indoors if you can do so safely.

Q. Are parts inspected before painting?

Inspect the part or vehicle to be painted to ensure that it is dry, clean, and rust free. Paint sticks to dry, clean surfaces, which in turn means a better, longer-lasting paint job.

Q. Are you using painting equipment that creates little waste?

As little as 30 percent of the paint may reach the target from conventional airless spray guns; the rest is lost as overspray. Paint solids from overspray are deposited on the ground where they can contaminate storm water. Other spray equipment that delivers more paint to the target and less overspray should be used:

- Electrostatic spray equipment
- Air-atomized spray guns
- High-volume/low-pressure spray guns
- Gravity-feed guns.

Q. Are employees trained to use spray equipment correctly?

Operator training can reduce overspray and minimize the amount of paint solids that can contaminate storm water. Correct spraying techniques also reduce the amount of paint needed per job. If possible, avoid spraying on windy days. When spraying outdoors, use a drop cloth or ground cloth to collect and dispose of overspray.

Q. Do you recycle paint, paint thinner, or solvents?

These materials can either be recycled at the facility or sent offsite for recycling. Some recycling options ranked by the level of effort required follow.

Least Effort:
• Dirty solvent can be reused for cleaning dirty spray equipment and parts before equipment is cleaned in fresh solvent. • Give small amounts of left-over paint to the customer for touchup.
Moderate Effort:
• Arrange for collection and transportation of paints, paint thinner, or spent solvents to a commercial recycling facility.
Most Effort:
• Install an onsite solvent recovery unit. If your facility creates large volumes of used solvents, paint, or paint thinner, you may consider buying or leasing an onsite still to recover used solvent for reuse. Contact your State hazardous waste management agency for more information about onsite recycling of used solvents.

Q. Are wastes separated?

Separating wastes makes recycling easier and may reduce treatment costs. Keep hazardous and nonhazardous wastes separate, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from nonchlorinated solvents (like petroleum distillate and mineral spirits). Check the materials data sheet for ingredients, or talk with your waste hauler or recycling company to learn which waste types can be stored together and which should be separated.

Q. Can you reduce the number of solvents you use?

Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can do a job as well as two different solvents.

Q. Do you use recycled products?

Many products made of recycled (i.e., refined or purified) materials are available. Buying recycled paints, paint thinner, or solvent products helps build the market for recycled materials.

SUMMARY OF PAINTING OPERATION BMPs

- Inspect parts prior to painting.
- Contain sanding wastes.
- Prevent paint waste from contacting storm water.
- Proper interim storage of waste paint, solvents, etc.
- Evaluate efficiency of equipment.
- Recycle paint, paint thinner, and solvents.
- Segregate wastes.
- Buy recycled products.

3.4 BMPs FOR VEHICLE AND EQUIPMENT WASHING

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. Wash water can contain high concentrations of oil and grease, phosphates, and high suspended solid loads (these and other potentially harmful substances can pollute storm water when deposited on the ground where they can be picked up by rainfall runoff). Vehicle wash water is considered to be a process wastewater and needs to be covered by an NPDES permit. Contact your permitting authority for information about how vehicle wash water is being regulated in your area.

The following questions are designed to help you find sources of storm water contamination from vehicle and equipment washing and to select BMPs to reduce those sources. Reading this section can help you eliminate, reduce, or recycle pollutants that otherwise may contaminate storm water. Also refer to Vehicle Washing BMP in Section 4.4.

Q. Have you considered using phosphate-free biodegradable detergents?

Phosphates, which are plant nutrients, can cause excessive growth of nuisance plants in water when they enter lakes or streams in wash water. Some States ban the use of detergents containing high amounts of phosphates. Contact your supplier about phosphate-free biodegradable detergents that are available on the market.

VEHICLE AND EQUIPMENT WASHING ACTIVITIES THAT CAN CONTAMINATE STORM WATER:

- Outside equipment or vehicle cleaning (washing or steam cleaning)
- Wash water discharged directly to the ground or storm water drain

Q. Are vehicles, equipment, or parts washed over the open ground?

Used wash water contains high concentrations of solvents, oil and grease, detergents, and metals. Try not to wash parts or equipment outside. Washing over impervious surfaces like concrete, blacktop, or hardpacked dirt allows wash water to enter storm drains directly or deposits contaminants on the ground, where they are washed into storm drains when it rains. Washing over pervious ground such as sandy soils potentially can pollute ground water. Therefore, small parts and equipment washing should be done over a parts washing container where the wash water can be collected and recycled or disposed of properly.

EMPLOYEE INVOLVEMENT IS THE KEY:

Getting employees interested in reducing waste is the key to a successful storm water pollution prevention plan. Discuss pollution prevention with your employees. They are most familiar with the operations that generate wastes and may have helpful waste reduction suggestions. Consider setting up an employee award program to promote pollution prevention.

If you are washing large equipment or vehicles, and have to wash outside, designate a specific area for washing. This area should be bermed to collect the wastewater and graded to direct the wash water to a treatment facility. Consider filtering and recycling vehicle wash water. If recycling is not practical, the wastewater can be discharged to the sanitary sewer. Contact your local sewer authority to find out whether treatment is required before wash water is discharged to the sewer (pretreatment).

SUMMARY OF VEHICLE AND EQUIPMENT WASHING BMPs
• Consider use of phosphate-free detergents. • Use designated cleaning areas. • Consider recycling wash water.

3.5 BMPs FOR LOADING AND UNLOADING MATERIALS

Loading/unloading operations usually take place outside on docks or terminals. Materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by rainfall runoff or when the area is cleaned. Rainfall may wash off pollutants from machinery used to unload or load materials. The following questions are designed to help you find sources of storm water contamination from loading and unloading materials and choose BMPs to reduce or eliminate those sources. Reading this section can start you on the road to eliminating, reducing, or recycling pollutants that otherwise may contaminate storm water. Also refer to the BMP on Loading and Unloading by Air Pressure or Vacuum in Section 4.2.

Q. Are tank trucks and material delivery vehicles located where spills or leaks can be contained?

Loading/unloading equipment and vehicles should be located so that leaks can be contained in existing containment and flow diversion systems.

Q. Is loading/unloading equipment checked regularly for leaks?

Check vehicles and equipment regularly for leaks, and fix any leaks promptly. Common areas for leaks are valves, pumps, flanges, and connections. Look for dust or fumes. These are signs that material is being lost during unloading/loading operations.

LOADING AND UNLOADING ACTIVITIES THAT CAN CONTAMINATE STORM WATER:

- Pumping of liquids or gases from barge, truck or rail car to a storage facility or vice versa
- Pneumatic transfer of dry chemicals to or from the loading and unloading vehicles
- Transfer by mechanical conveyor systems
- Transfer of bags, boxes, drums, or other containers by forklift, trucks, or other material handling equipment

Q. Are loading/unloading docks or areas covered to prevent exposure to rainfall?

Covering loading and unloading areas, such as building overhangs at loading docks, can reduce exposure of materials, vehicles, and equipment to rain.

Q. Are loading/unloading areas designed to prevent storm water runon?

Runon is storm water created from other areas that flows or "runs on" to your property or site. Runon flowing across loading/unloading areas can wash contaminants into storm drains. Runon can be minimized by:

- Grading, berming, or curbing the area around the loading area to direct runon away from the area
- Positioning roof down spouts so storm water is directed away from loading sites and equipment and preferably to a grassy or vegetated area where the storm water can soak into the ground.

SUMMARY OF LOADING/UNLOADING OPERATIONS BMPs
• Contain leaks during transfer. • Check equipment regularly for leaks. • Limit exposure of material to rainfall. • Prevent storm water runon.

3.6 BMPs FOR LIQUID STORAGE IN ABOVE-GROUND TANKS

Accidental releases of chemicals from above-ground liquid storage tanks can contaminate storm water with many different pollutants. Materials spilled, leaked, or lost from storage tanks may accumulate in soils or on other surfaces and be carried away by rainfall runoff. The following questions can help you find sources of storm water contamination from above-ground storage tanks and select BMPs to reduce or eliminate those sources. Also refer of the BMPs listed in Section 4.2 on exposure minimization and Section 4.3 on exposure mitigation for more information.

THE MOST COMMON CAUSES OF UNINTENTIONAL RELEASES FROM TANKS:

- External corrosion and structural failure
- Installation problems
- Spills and overfills due to operator error
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves)
- Leaks or spills during pumping of liquids or gases from barges, trucks, or rail cars to a storage facility or vice versa

Q. Do storage tanks contain liquid hazardous materials, hazardous wastes, or oil?

Storage of oil and hazardous materials must meet specific standards set by Federal and State laws. These standards include SPCC plans, secondary containment, installation, integrity and leak detection monitoring, and emergency preparedness plans. Federal regulations set specific standards for preventing runon and collecting runoff from hazardous waste storage, disposal, or treatment areas. These standards apply to container storage areas and other areas used to store, treat, or dispose of hazardous waste. If the collected storm water is a hazardous waste, it must be managed as a hazardous waste in accordance with all applicable State and Federal environmental regulations. States may also have standards about controlling runon and runoff from hazardous waste treatment, storage, and disposal areas. To find out more about storage requirements, call the toll-free EPA RCRA hotline at 1-800-424-9346 or contact your State hazardous waste management agency.

Q. Are operators trained in correct operating procedures and safety activities?

Well-trained employees can reduce human errors that lead to accidental releases or spills.

Q. Do you have safeguards against accidental releases?

Engineered safeguards can help prevent operator errors that may cause the accidental release of pollutants. Safeguards include:

- Overflow protection devices on tank systems to warn the operator or to automatically shut down transfer pumps when the tank reaches full capacity
- Protective guards around tanks and piping to prevent vehicle or forklift damage
- Clearly tagging or labeling of valves to reduce human error.

Q. Are the tank systems inspected and is tank integrity tested regularly?

Visually inspect the tank system to identify problem areas before they lead to a release. Correct any problems or potential problems as soon as possible. An audit of a newly installed tank system by a registered and specially trained professional engineer can identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets. After installation, have operators visually inspect the tank system on a routine basis. Areas to inspect include tank foundations, connections, coatings, tank walls, and the piping system. Look for corrosion, leaks, straining of tank support structures from leaks, cracks, scratches in protective coatings, or other physical damage that may weaken the tank system. Integrity testing should be done periodically by a qualified professional.

Q. Are tanks bermed or surrounded by a secondary containment system?

A secondary containment system around both permanent and temporary tanks allows leaks to be more easily detected and contains spills or leaks. Methods include berms, dikes, liners, vaults, and double-walled tanks. See Chapter 4 for additional information on containment and spill control.

SUMMARY OF BMPs FOR LIQUID STORAGE IN ABOVE-GROUND TANKS

- Comply with applicable State and Federal laws.
- Properly train employees.
- Install safeguards against accidental releases.
- Routinely inspect tanks and equipment.
- Consider installing secondary containment.

3.7 BMPs FOR INDUSTRIAL WASTE MANAGEMENT AREAS AND OUTSIDE MANUFACTURING

Storm water runoff from areas where industrial waste is stored, treated, or disposed of can be polluted. Outside manufacturing activities can also contaminate storm water runoff. Activities such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, or operations that use hazardous materials are particularly dangerous. Wastes spilled, leaked, or lost from waste management areas or outside manufacturing activities may build-up in soils or on other surfaces and be carried away by rainfall runoff. There is also a potential for liquid wastes from lagoons or surface impoundments to overflow to surface waters or soak the soil where they can be picked up by storm water runoff. Possible storm water contaminants include toxic compounds, oil and grease, paints or solvents, heavy metals, and high levels of suspended solids.

The best way to reduce the potential for storm water contamination from both waste management areas and outside manufacturing activities is to reduce the amount of waste that is created and, consequently, the amount that must be stored or treated. The following questions are designed to help you find BMPs that can eliminate or reduce the amount or toxicity of industrial wastes as well as minimize contamination of storm water from existing waste management areas. Waste reduction BMPs are appropriate for a wide range of industries and are designed to provide ideas on ways to reduce wastes. Turn to Appendix D for a list of State and Federal pollution prevention resources that can provide more information and assistance in choosing industrial waste reduction BMPs.

Q. Have you looked for ways to reduce waste at your facility?

The first step to reducing wastes is to assess activities at your facility. The assessment is designed to find situations at your facility where you can eliminate or reduce waste generation, emissions, and environmental damage. The assessment involves steps very similar to those used to develop your Storm Water Pollution Prevention Plan, such as collecting process-specific information; setting pollution prevention targets; and developing, screening, and selecting waste reduction options for further study. Starting a waste reduction program at your facility has many potential benefits. Some of these benefits are direct (e.g., cost savings from reduced raw material use), while others are indirect (e.g., avoided waste disposal fees).

EPA has developed a series of industry-specific pollution prevention waste minimization guidance manuals. The manuals contain steps for assessing your facility's opportunity for reducing waste and describe source reduction and recycling choices. The manuals currently available are listed in Appendix D.

INDUSTRIAL WASTE MANAGEMENT ACTIVITIES OR AREAS THAT CAN CONTAMINATE STORM WATER:

- Landfills
- Waste piles
- Wastewater and solid waste treatment and disposal:
  - Waste pumping
  - Additions of treatment chemicals
  - Mixing
  - Aeration
  - Clarification
  - Solids dewatering
- Land application

Q. Have you considered waste reduction BMPs?

There are many different types of BMPs that can help eliminate or reduce the amount of industrial waste generated at your facility. Some of these BMPs are listed below and referenced in Appendix D.

- Production planning and sequencing
- Process or equipment modification
- Raw material substitution or elimination
- Loss prevention and housekeeping
- Waste segregation and separation
- Closed-loop recycling
- Training and supervision
- Reuse and recycling.

OUTSIDE MANUFACTURING ACTIVITIES OR SITUATIONS THAT CAN CONTAMINATE STORM WATER:

- Processes or equipment that generate dusts, vapors, or emissions
- Outside storage of hazardous materials or raw materials
- Dripping or leaking fluids from equipment or processes
- Liquid wastes discharged directly onto the ground or into the storm sewer

Q. Are industrial waste management and outside manufacturing areas checked often for spills and leaks?

By checking waste management areas for leaking containers or spills, you can prevent wastes from contaminating storm water. Look for containers that are rusty, corroded, or damaged. Transfer wastes from these damaged containers into safe containers. Close the lids on dumpsters to prevent rain from washing wastes out of holes or cracks in the bottom of the dumpster. In outside manufacturing areas, look for leaking equipment (e.g., valves, lines, seals, or pumps) and fix leaks promptly. Inspect rooftop and other outdoor equipment (e.g., HVAC devices, air pollution control devices, transformers, piping, etc.) for leaks or dust concentrations.

Q. Are industrial waste management areas or manufacturing activities covered, enclosed, or bermed?

The best way to avoid contaminating storm water from existing waste management and manufacturing areas is to prevent storm water runon or rain from entering or contacting these areas. This can be done by:

- Preventing direct contact with rain
- Moving the activity indoors after ensuring that all safety concerns such as fire hazard and ventilation are addressed
- Covering the area with a permanent roof

- Covering waste piles with a temporary covering material such as a reinforced tarpaulin, polyethylene, polyurethane, polypropylene, or Hypalon
- Minimizing storm water runon by enclosing the area or building a berm around the area.

Q. Are vehicles used to transport wastes to the land disposal or treatment site equipped with anti-spill equipment?

Transport vehicles equipped with spill prevention equipment can prevent spills of wastes during transport. Examples include:

- Vehicles equipped with baffles for liquid wastes
- Trucks with sealed gates and spill guards for solid wastes
- Trucks with tarps.

Q. Do you use loading systems that minimize spills and fugitive losses such as dust or mists?

Wastes lost during loading or unloading can contaminate storm water. Vacuum transfer systems minimize waste loss.

Q. Are sediments or wastes prevented from being tracked offsite?

Wastes and sediments tracked offsite can end up on streets where they are picked up by storm water runoff. This can be avoided by using vehicles with specially designed tires, washing vehicles in a designated area before they leave the site, and controlling the wash water.

Q. Is storm water runoff minimized from the land disposal site?

You can take certain precautions to minimize the runoff of polluted storm water from land application sites. Some precautions are detailed below.

DO YOU OWN OR OPERATE A HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITY?

Federal and State laws establish strict standards for managing solid and hazardous wastes. If you are not sure whether you own or operate a hazardous waste treatment, storage, or disposal facility, call the toll-free EPA RCRA hotline at 1-800-424-9346 or contact your State hazardous waste management agency. Federal regulations contain specific standards about preventing runon and collecting runoff from hazardous waste storage, disposal, or treatment areas. These standards apply to land treatment units, landfills, waste piles, container storage areas, and other areas used to store, treat, or dispose of hazardous waste. If the collected storm water is a hazardous waste, it must be managed in accordance with all applicable State and Federal environmental regulations. States may also have standards about controlling runon and runoff from hazardous waste treatment, storage, and disposal areas.

- Choose the land application site carefully. Characteristics that help prevent runoff include slopes under 6 percent, permeable soils, a low water table, locations away from wetlands or marshes, and closed drainage systems.

- Avoid applying waste to the site when it is raining or when the ground is frozen or saturated with water. Grow vegetation on areas dedicated to land disposal to stabilize the soils and reduce the volume of surface water runoff from the site.

- Maintain adequate barriers between the land application site and receiving waters.

- Erosion control techniques might include mulching and matting, filter fences, straw bales, diversion terracing, or sediment basins. For a detailed description of erosion control techniques, see Chapter 4.

- Perform routine maintenance to ensure that erosion control or site stabilization measures are working.

SUMMARY OF INDUSTRIAL WASTE MANAGEMENT AND OUTSIDE MANUFACTURING BMPs
• Conduct a waste reduction assessment. • Institute industrial waste source reduction and recycling BMPs. • Prevent runoff and runon from contacting the waste management area. • Minimize runoff from land application sites.

3.8 BMPs FOR OUTSIDE STORAGE OF RAW MATERIALS, BY-PRODUCTS, OR FINISHED PRODUCTS

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute storm water. Storm water can become contaminated by a wide range of contaminants (e.g., metals, oil, and grease) when solid materials wash off or dissolve into water, or by spills or leaks. The following questions are designed to help you identify potential sources of storm water contamination and select BMPs that can reduce or eliminate those sources. Reading this section can help you eliminate or reduce pollutants that otherwise may contaminate storm water.

Q. Are materials protected from rainfall, runon, and runoff?

The best way to avoid contaminating storm water from outside material storage areas is to prevent storm water runon or rain from coming in contact with the materials. This can be done by:

- Storing the material indoors
- Covering the area with a roof
- Covering the material with a temporary covering made of polyethylene, polyurethane, polypropylene, or Hypalon.
- Minimizing storm water runon by enclosing the area or building a berm around the area.

ARE ANY OF THESE MATERIALS STORED OUTSIDE OR IN AREAS WHERE THEY CAN CONTAMINATE STORM WATER?

- Fuels
- Raw materials
- By-products
- Intermediates
- Final products
- Process residuals

SUMMARY OF BMPs FOR OUTSIDE STORAGE OF RAW MATERIALS, BY-PRODUCTS, OR FINISHED PRODUCTS

- Cover or enclose materials.

3.9 BMPs FOR SALT STORAGE FACILITIES

Salt left exposed to rain or snow can be lost. Salt spilled or blown onto the ground during loading and unloading will dissolve in storm water runoff. Storm water contaminated with salt can be harmful to vegetation and aquatic life. Salty storm water runoff soaking into the ground may contaminate ground water and make it unsuitable as a drinking water supply. The following BMPs will help reduce storm water contamination from salt storage and transfer activities. See Chapter 4 for more detailed information on covering storage areas.

SALT STORAGE ACTIVITIES THAT CAN CONTAMINATE STORM WATER:
• Salt stored outside in piles or bags that are exposed to rain or snow
• Salt loading and unloading areas located outside or in areas where spilled salt can contaminate storm water.

Q. Are salt piles protected from rain?

The best way to prevent salt from contaminating storm water is to eliminate or limit the exposure of salt to rain. Preventing contact with rain also protects against salt loss and prevents salt from absorbing moisture and becoming caked or lumpy and making it difficult to handle and use.

- Store salt under a roof. This is the best way to stop direct contact with rain.

If salt must be stored outside:

- Build the storage pile on asphalt to reduce the potential for ground water contamination
- Cover the pile with a temporary covering material such as polyethylene, polyurethane, polypropylene, or Hypalon.

Q. Is storm water runon prevented from contacting storage piles and loading and unloading areas?

Storm water runon can be minimized by enclosing the area or building berms around storage, loading, and unloading areas.

SUMMARY OF SALT STORAGE FACILITIES BMPs
• Put it under a roof.
• Use temporary covers.
• Enclose or berm transfer areas.

CHAPTER 4

SITE-SPECIFIC INDUSTRIAL STORM WATER BMPs

This chapter describes some of the possible Best Management Practices (BMPs) that you might include in your Storm Water Pollution Prevention Plan so that pollutants from your site do not mix with storm water.

Table 4.1 provides an easy index of the BMP descriptions that follow. The BMPs are grouped by section into six categories: Flow Diversion Practices; Exposure Minimization Practices; Mitigative Practices; Other Preventive Practices; Sediment and Erosion Prevention Practices; and Infiltration Practices.

The following information is provided for each BMP: (1) description of the BMP; (2) when and where the BMP can be used; (3) factors that should be considered when using the BMP; and (4) advantages and disadvantages of the BMP. More detailed fact sheets for a limited number of the Sediment and Erosion Prevention Practices are included as Appendix E. When designing these structural controls, EPA recommends that you refer to any State or local storm water management design standards.

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4.1 FLOW DIVERSION PRACTICES

Structures that divert stream flow (such as gutters, drains, sewers, dikes, and graded pavement) are used as BMPs in two ways. First, flow diversion structures, called storm water conveyances, may be used to channel storm water away from industrial areas so that pollutants do not mix with the storm water. Second, they also may be used to carry pollutants directly to a treatment facility. This section briefly describes flow diversion as a BMP for industrial storm water.

Storm Water Conveyances (Channels/Gutters/Drains/Sewers)

What Are They

Storm water conveyances such as channels, gutters, drains, and sewers, collect storm water runoff and direct its flow. A group of connecting conveyances is sometimes installed at an industrial facility to create a storm water collection system. Storm water conveyances can be used for two different purposes. The first purpose is to keep uncontaminated storm water from coming in contact with areas of an industrial site where it may become contaminated with pollutants. This can be accomplished by collecting the storm water in a conveyance and by changing the direction of flow away from those areas. The second purpose is to collect and carry the storm water that has already come into contact with industrial areas and become contaminated to a treatment facility.

Storm water conveyances can be constructed or lined with many different materials, including concrete, clay tiles, asphalt, plastics, metals, riprap, compacted soils, and vegetation. The type of material used depends on the use of the conveyance. These conveyances can be temporary or permanent.

When and Where to Use Them

Storm water conveyances work well at most industrial sites. Storm water can be directed away from industrial areas by collecting it in channels or drains before it reaches the areas. In addition, conveyances can be used to collect storm water downhill from industrial areas and keep it separate from runoff that has <u>not</u> been in contact with those areas. When potentially contaminated storm water is collected in a conveyance like this, it can be directed to a treatment facility on the site if necessary. (If a pollutant is spilled, it should not be allowed to enter a storm water conveyance or drain system.)

What to Consider

In planning for storm water conveyances, consider the amount and speed of the typical storm water runoff. Also, consider the patterns in which the storm water drains so that the channels may be located to collect the most flow and can be built to handle the amount of water they will receive. When deciding on the type of material for the conveyance, consider the resistance of the material, its durability, and compatibility with any pollutants it may carry.

Conveyance systems are most easily installed when a facility is first being constructed. Use of existing grades will decrease costs. Grades should be positive to allow for the continued movement of the runoff through the conveyance system; however, grades should not create an increase in velocity that causes an increase in erosion (this will also depend upon what materials the conveyance is lined with and the types of outlet controls that are provided).

Ideally, storm water conveyances should be inspected to remove debris within 24 hours of rainfall, or daily during periods of prolonged rainfall, since heavy storms may clog or damage them. It is important to repair damages to these structures as soon as possible.

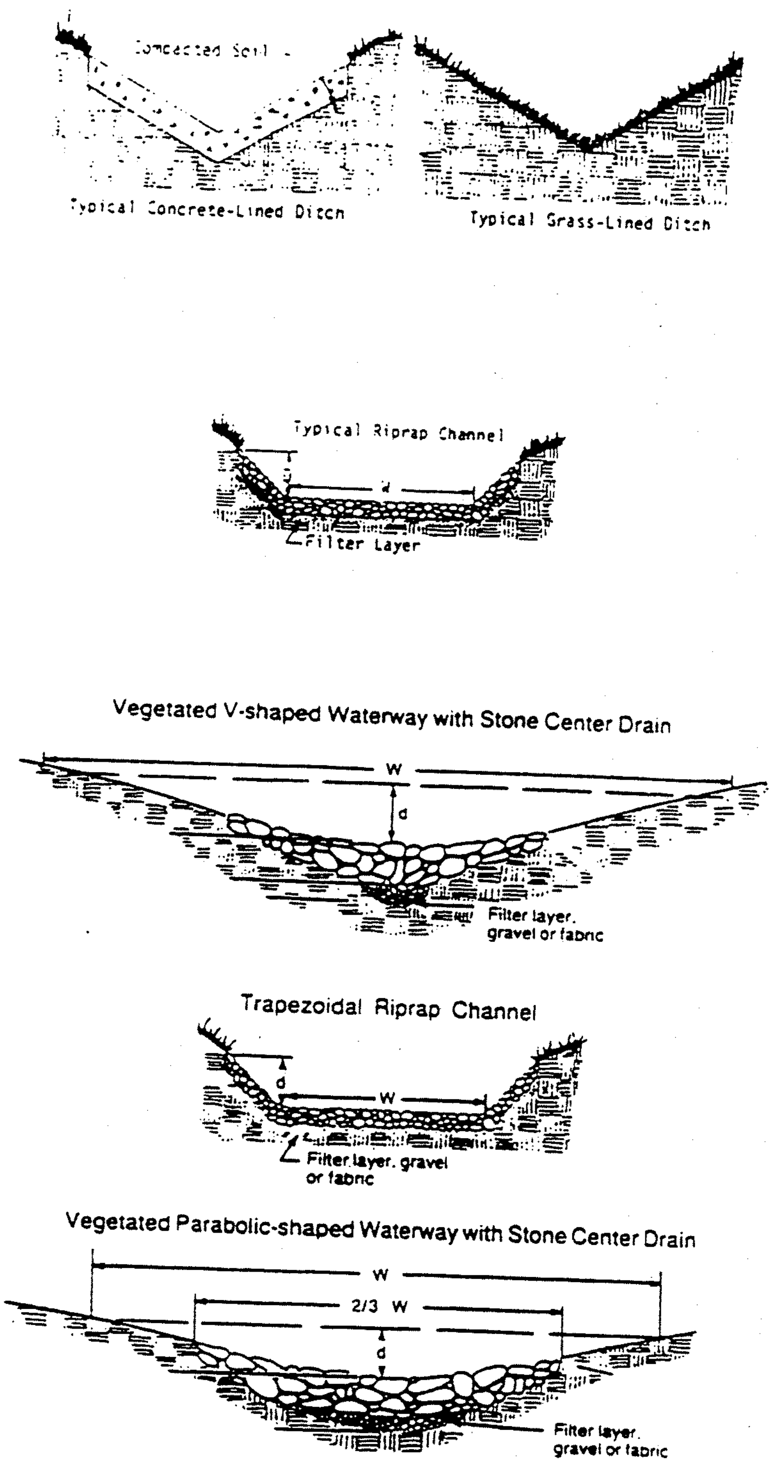


FIGURE 4.1 TYPICAL STORM WATER CONVEYANCE CROSS SECTIONS (Modified from Commonwealth of Virginia, 1980)

Advantages of Storm Water Conveyances (Channels/Gutters/Drains/Sewers)
• Direct storm water flows around industrial areas • Prevent temporary flooding of industrial site • Require low maintenance • Provide erosion resistant conveyance of storm water runoff • Provide long-term control of storm water flows
Disadvantages of Storm Water Conveyances (Channels/Gutters/Drains/Sewers)
• Once flows are concentrated in storm water conveyances, they must be routed through stabilized structures all the way to their discharge to the receiving water or treatment plant to minimize erosion • May increase flow rates • May be impractical if there are space limitations • May not be economical, especially for small facilities or after a site has already been constructed

Diversion Dikes

What Are They

Diversion dikes or berms are structures used to block runoff from passing beyond a certain point. Temporary dikes are usually made with compacted soil. More permanent ridges are constructed out of concrete, asphalt, or similar materials.

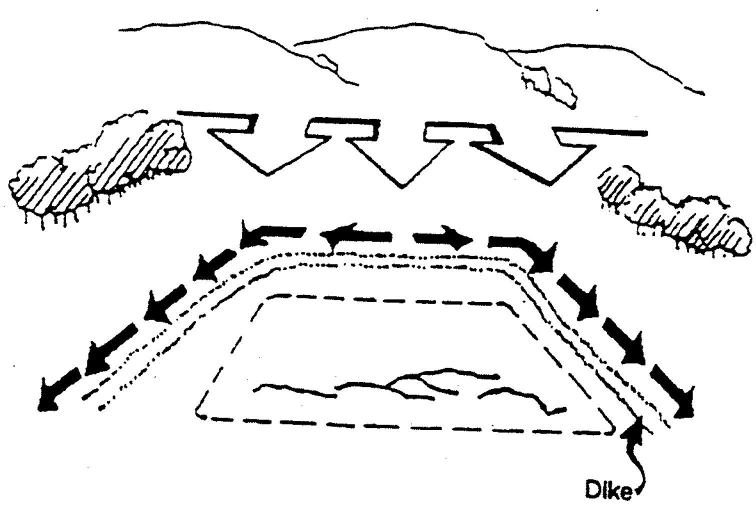


FIGURE 4.2 DIVERSION DIKES
(Modified from North Carolina, 1988)

When and Where to Use Them

Diversion dikes are used to prevent the flow of storm water runoff onto industrial areas. Limiting the volume of flow across industrial areas reduces the volume of storm water that may carry pollutants from the area, requiring treatment for pollutant removal. This BMP is suitable for industrial sites where significant volumes of storm water runoff tend to flow onto active industrial areas. Typically, dikes are built on slopes just uphill from an industrial area together with some sort of a conveyance such as a swale. The storm water conveyance is necessary to direct the water away from the dike so that the water will not pool and seep through the dike.

What to Consider

In planning for the installation of dikes, consider the slope of the drainage area, the height of the dike, the size of rainfall event it will need to divert, and the type of conveyance that will be used with the dike. Steeper slopes result in higher volumes of runoff and higher velocities; therefore, the dike must be constructed to handle this situation. Remember that dikes are limited in their ability to manage large volumes of runoff.

Ideally, dikes are installed before industrial activity begins. However, dikes can be easily constructed at any time. Temporary dikes (usually made of dirt) generally only last for 18 months or less, but they can be made into permanent structures by stabilizing them with vegetation. Vegetation is crucial for preventing the erosion of the dike.

Dikes should be inspected regularly for damage. This is especially important after storm events since a heavy rain may wash parts of a temporary dike away. Any necessary repairs should be made immediately to make sure the structure continues to do its job.

Advantages of Diversion Dikes
• Effectively limit storm water flows over industrial site areas • Can be installed at any time • Are economical temporary structures, when built from soil onsite • Can be converted from temporary to permanent at any time
Disadvantages of Diversion Dikes
• Are not suitable for large drainage areas unless there is a gentle slope • May require maintenance after heavy rains

Graded Areas and Pavement

What Is It

Land surfaces can be graded or graded and paved so that storm water runoff is directed away from industrial activity areas. The slope of the grade allows the runoff to flow, but limits the runoff from washing over areas that may be contaminated with pollutants. Like conveyances and dikes, graded areas can prevent runoff from contacting industrial areas and becoming contaminated with pollutants from these areas. Grading can be a permanent or temporary control measure.

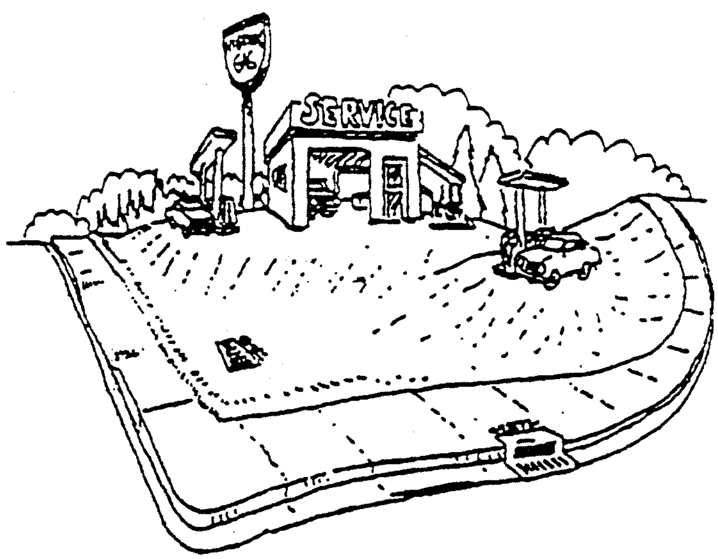


FIGURE 4.3 EXAMPLE OF GRADED PAVEMENT
(Modified from Santa Clara Valley, 1990)

When and Where to Use It

Grading land surfaces is appropriate for any industrial site that has outdoor activities that may contaminate storm water runoff, such as parking lots or outdoor storage areas. Figure 4.3 illustrates the use of graded pavement in preventing runoff from washing over a service station site. Grading is often used with other practices, such as coverings, buffer zones, and other practices to reduce the runoff velocity and provide infiltration of the uncontaminated runoff, or to direct pollutant runoff to storm water treatment facilities.

What to Consider

When designing graded areas and pavement, both control and containment of runoff flows should be considered. The grading should control the uncontaminated flow by diverting it around areas that may have pollutants. The grading should also contain the contaminated flows or divert them to treatment facilities.

When regrading and paving an industrial area, the use of concrete paving instead of asphalt should be considered. This is especially important in potential spill sites or hazardous material storage areas. Asphalt absorbs organic pollutants and can be slowly dissolved by some fluids, thus becoming a possible source of contaminants itself. This control measure should be used with a cover, such as a roof, in areas where contaminants are of concern (see Covering BMP) so that rain or snow does not fall on the area and wash the contaminants down slope.

Inspect paving regularly for cracks that may allow contaminants to seep into the ground. Also, check to make sure that the drains receiving the storm water flow from the paved area remain unclogged with sediment or other debris so that low areas do not flood and wash over the areas where the contaminants may be.

Advantages of Graded Areas and Pavement
• Is effective in limiting storm water contact with contaminants • Is relatively inexpensive and easily implemented
Disadvantages of Graded Areas and Pavement
• May be uneconomical to regrade and resurface large areas • May not be effective during heavy precipitation

4.2 EXPOSURE MINIMIZATION PRACTICES

By eliminating or minimizing the possibility of storm water coming into contact with pollutants, facilities can eliminate or minimize the contamination of storm water discharges associated with their industrial activity. As a result, fewer materials will be carried away by storm water runoff, the costs of collecting and treating contaminated storm water will be decreased, and safety and environmental liabilities that result from spills and leaks will be reduced.

Completely eliminating the exposure of materials to storm water is not always possible, however. For many industrial facilities, enclosure of facility grounds is not technologically or economically possible. Therefore, this section describes several simple and inexpensive structural and nonstructural BMPs that a facility can use to minimize the exposure of materials to storm water.

Containing spills is one of the primary methods of minimizing exposure of contaminants to storm water runoff. Spill containment is used for enclosing any drips, overflows, leaks, or other liquid material releases, as well as for isolating and keeping pollutant spills away from storm water runoff.

There are numerous spill containment methods, ranging from large structural barriers to simple, small drip pans. The benefits of each of these practices vary based on cost, need for maintenance, and size of the spill they are designed to control. This section describes several containment methods, including:

- Containment Diking
- Curbing
- Drip Pans
- Catch Basins
- Sumps.

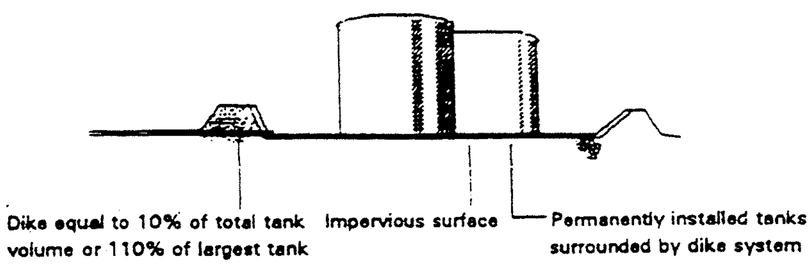
Other practices commonly used to minimize exposure of contaminants are also discussed, including the following:

- Covering
- Vehicle Positioning
- Loading and Unloading by Air Pressure or Vacuum.

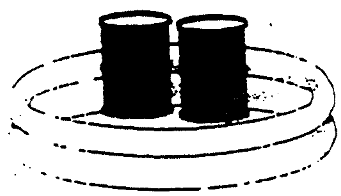
Containment Diking

What Is It

Containment dikes are temporary or permanent earth or concrete berms or retaining walls that are designed to hold spills. Diking, one of the most common types of containment, is an effective method of pollution prevention for above-ground liquid storage tanks and rail car or tank truck loading and unloading areas. Diking can provide one of the best protective measures against the contamination of storm water because it surrounds the area of concern and holds the spill, keeping spill materials separated from the storm water outside of the diked area.



Containment Diking for Large Storage Areas



Containment Diking for Small Storage Areas

FIGURE 4.4 CONTAINMENT DIKING
(Modified from MWCOG, 1992)

When and Where to Use It

Diking can be used at any industrial facility but is most commonly used for controlling large spills or releases from liquid storage areas and liquid transfer areas.

What to Consider

Containment dikes should be large enough to hold an amount equal to the largest single storage tank at the particular facility plus the volume of rainfall. For rail car and tank truck loading and unloading operations, the diked area should be capable of holding an amount equal to any single tank truck compartment. Materials used to construct the dike should be strong enough to safely hold spilled materials. The materials used usually depend on what is available onsite and the substance to be contained, and may consist of earth (i.e., soil or clay), concrete, synthetic materials (liners), metal, or other impervious materials. In general, strong acids and bases may react with metal containers, concrete, and some plastics, so where spills may consist of these substances, other alternatives should be considered. Some of the more reactive organic chemicals may also need to be contained with special liners. If there are any questions about storing chemicals in certain dikes because of their construction materials, refer to the Material Safety Data Sheets (MSDSs).

Containment dikes may need to be designed with impervious materials to prevent leaking or contamination of storm water, surface, and ground water supplies.

Similarly, uncontrolled overflows from diked areas containing spilled materials or contaminated storm water should be prevented to protect nearby surface waters or ground waters. Therefore, dikes should have either pumping systems (see Sumps BMP) or vacuum trucks available to remove the spilled materials. When evaluating the performance of the containment system, you should pay special attention to the overflow system, since it is often the source of uncontrolled leaks. If overflow systems do not exist, accumulated storm water should be released periodically. Contaminated storm water should be treated prior to release. Mechanical parts, such as pumps or even manual systems (e.g., slide gates, stopcock valves), may require regular cleaning and maintenance.

When considering containment diking as a BMP, you should consult local authorities about any regulations governing construction of such structures to comply with local and State requirements. Facilities located in a flood plain should contact their local flood control authority to ensure that construction of the dikes is permitted.

Inspections of containment dikes should be conducted during or after significant storms or spills to check for washouts or overflows. In addition, regular checks of containment dikes (i.e., testing to ensure that dikes are capable of holding spills) is recommended. Soil dikes may need to be inspected on a more frequent basis.

Changes in vegetation, inability of the structure to retain storm water dike erosion, or soggy areas indicate problems with the dike's structure. Damaged areas should be patched and stabilized immediately, where necessary. Earthen dikes may require special maintenance of vegetation, such as mowing and irrigation.

Advantages of Containment Diking
• Contains spills, leaks, and other releases and prevent them from flowing into runoff conveyances, nearby streams, or underground water supplies • Permits materials collected in dikes to be recycled • Is a common industry practice for storage tanks and already required for certain chemicals
Disadvantages of Containment Diking
• May be too expensive for some smaller facilities • Requires maintenance • Could collect contaminated storm water, possibly resulting in infiltration of storm water to ground water

Curbing

What Is It

Like containment diking, curbing is a barrier that surrounds an area of concern. Curbing functions in a similar way to prevent spills, leaks, etc. from being released to the environment by routing runoff to treatment or control areas. The terms curbing and diking are sometimes used interchangeably.

Because curbing is usually small-scale, it cannot contain large spills like diking can, however, curbing is common at many facilities in small areas where handling and transferring liquid materials occur.

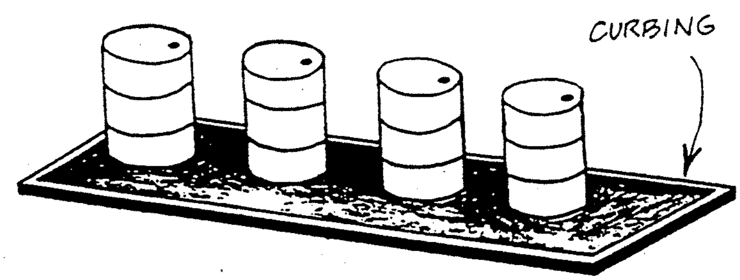


FIGURE 4.5 CURBING AROUND DRUM STORAGE AREA

When and Where to Use It

Curbing can be used at all industrial facilities. It is particularly useful in areas where liquid materials are transferred and as a storm water runoff control.

As with diking, common materials for curbing include earth, concrete, synthetic materials, metal, or other impenetrable materials. Asphalt is also a common material used in curbing.

What to Consider

For maximum efficiency of curbing, spilled materials should be removed immediately, to allow space for future spills. Curbs should have pumping systems, rather than drainage systems, for collecting spilled materials. Manual or mechanical methods, such as those provided by sump systems (see Sump BMP), can be used to remove the material. Curbing systems should be maintained through curb repair (patching and replacement).

When using curbing for runoff control, facilities should protect the berm by limiting traffic and installing reinforced berms in areas of concern.

Spills of materials that are stored within a curbed area can be tracked outside of that area when personnel and equipment leave the area. This tracking can be minimized by grading within the curbing to direct the spilled materials to a down-slope side of the curbing. This will keep the materials away from personnel and equipment that pass through the area. It will also allow the materials to accumulate in one area making cleanup much easier.

Inspections should also be conducted before forecasted rainfall events and immediately after storm events. If spilled or leaked materials are observed, cleanup should start immediately. This will prevent overflows and/or contamination of storm water runoff. In addition, prompt cleanup of materials will prevent dilution by rainwater, which can adversely affect recycling opportunities. Inspection of curbed areas should be conducted regularly, to clear clogging debris. Because curbing is sized to contain small spill volumes, maintenance should also be conducted frequently to prevent overflow of any spilled materials.

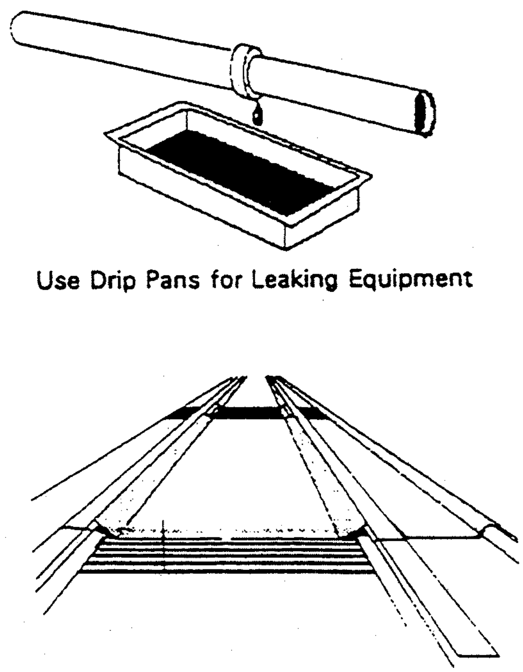
Advantages of Curbing
• Is an excellent method to control runon • Is inexpensive • Is easily installed • Materials spilled within curbed areas can be recycled • Exists as a common industry practice
Disadvantages of Curbing
• Is not effective for holding large spills • May require more maintenance than diking

Drip Pans

What Are They

Drip pans are small depressions or pans used to contain very small volumes of leaks, drips, and spills that occur at a facility. Drip pans can be depressions in concrete, asphalt, or other impenetrable materials or they can be made of metals, plastic, or any material that does not react with the dripped chemicals. Drip pans can be temporary or permanent.

Drip pans are used to catch drips from valves, pipes, etc. so that the materials or chemicals can be cleaned up easily or recycled before they can contaminate storm water. Although leaks and drips should be repaired and eliminated as part of a preventive maintenance program, drip pans can provide a temporary solution where repair or replacement must be delayed. In addition, drip pans can be an added safeguard when they are positioned beneath areas where leaks and drips may occur.



Use Drip Pans for Leaking Equipment

Use Drip Pans in Loading and Unloading Areas

FIGURE 4.6 USES FOR DRIP PANS
(Modified from Washington State, 1992)

When and Where to Use Them

Drip pans can be used at any industry where valves and piping are present and the potential for small volume leakage and dripping exist.

What to Consider

When using drip pans, consider the location of the drip pan, weather conditions, the type of material to be used for the drip pan, and how it will be cleaned.

The location of the drip pan is important. Because drip pans must be inspected and cleaned frequently, they must be easy to reach and remove. In addition, take special care to avoid placing drip pans in precarious positions such as next to walkways, on uneven pavement/ground, or sitting on pipelines. Drip pans in these locations are easily overturned and may present a safety hazard, as well as an environmental hazard.

Weather conditions are also important factors. Heavy winds and rainfall move or damage drip pans because of their small size and their light weight (if not built-in). To prevent this, secure the pans by installing or anchoring them. Drip pans may be placed on platforms or behind wind blocks or tied down.

For drip pans to be effective, employees must pay attention to the pans and empty them when they are nearly full. Because of their small holding capacities, drip pans will easily overflow if not emptied. Also, recycling efforts can be affected if storm water accumulates in drip pans and dilutes the spilled material. It is important to have clearly specified and easily followed practices of reuse/recycle and/or disposal, especially the disposal of hazardous materials. Many facilities dump the drip pan contents into a nearby larger volume storage container and periodically recycle the contents of the storage container.

In addition, frequent inspection of the drip pans is necessary due to the possibility of leaks in the pan itself or in piping or valves that may occur randomly or irregular slow drips that may increase in volume. Conduct inspections before forecasted rainfall events to remove accumulated materials and immediately after storm events to empty storm water accumulations.

Advantages of Drip Pans
• Are inexpensive
• Are easily installed and simple to operate
• Allow for reuse/recycle of collected material
• Empty or discarded containers may be reused as drip pans
Disadvantages of Drip Pans
• Contain small volumes only
• Must be inspected and cleaned frequently
• Must be secured during poor weather conditions
• Contents may be disposed of improperly unless facility personnel are trained in proper disposal methods

Collection Basins

What Are They

Collection basins, or storage basins, are permanent structures where large spills or contaminated storm water are contained and stored before cleanup or treatment. Collection basins are designed to receive spills, leaks, etc. that may occur and prevent these materials from being released to the environment. Unlike containment dikes, collection basins can receive and contain materials from many locations across a facility.

Collection basins are commonly confused with treatment units such as ponds, lagoons, and other containment structures. Collection basins differ from these structures because they are designed to temporarily store storm water rather than treat it.

When and Where to Use Them

Collection basins are appropriate for all industrial sites where space allows. Collection basins are particularly useful for areas that have a high spill potential.

What to Consider

The design and installation considerations for collection basins include sizing the basin either to hold a certain amount of spill or a certain size storm, or both. In designing the collection system, the type of material for the conveyances, compatibility of various materials to be carried through the system, and requirements for compliance with State and local regulations should be considered. Ideally, the system should function to route the materials quickly and easily to the collection basin.

When spills occur, the collection system must route the spill or storm water immediately to the collection basin. After a spill is contained, the collection system and basin may require cleaning. Remove the collection basin contents immediately to prevent an unintentional release and recycle the spilled material as much as possible. Inspect the structure on a regular basis and after storm events or spills. Depending upon the types of pollutants that may be in the storm water, or are collected as spills, design of the basin may require a liner to prevent infiltration into the ground water. Make sure that the installation of this BMP does not violate State ground water regulations.

If it is possible that the collection basin may handle combustible or flammable spilled materials, explosion-proof pumping equipment and controls or other appropriate precautions should be taken to prevent explosions or fires. Consult OSHA and local safety codes and standards for specific requirements and guidance.

Advantages of Collection Basins
• Can store contaminated storm water until directed to a treatment facility • Can collect spills for recycling where materials are separated
Disadvantages of Collection Basins
• May need a conveyance system for increased effectiveness • May collect materials that are not compatible • May reduce the potential for recycling materials by collecting storm water, which dilutes the materials • May create ground water problems if pollutants infiltrate into ground

Sumps

What Are They

Sumps are holes or low areas that are structured so that liquid spills or leaks will flow down toward a particular part of a containment area. Frequently, pumps are placed in a depressed area and are turned on automatically to transfer liquids away from the sump when the level of liquids gets too high. Sumps can be temporary or permanent.

When and Where to Use Them

Sumps can be used at all facilities. Sumps are used with other spill containment and treatment measures and can be located almost anywhere onsite. Sumps are frequently located in low lying areas within material handling or storage areas.

What to Consider

When designing and installing a sump system, consider the pump location, function, and system alarms. Design and install the sump in the lowest lying area of a containment structure, allowing for materials to gather in the area of the sump. Construct the sump of impenetrable materials and provide a smooth surface so that liquids are funneled toward the pump. It may be appropriate to house the pumps in a shed or other structure for protection and stabilization.

There are numerous factors that should be considered when purchasing a pump. Base the size of the pump on the maximum expected volume to be collected in the containment structure. In some cases, more than one pump may be appropriate. Typically, pumps that can be submerged under the spill are the most appropriate for areas where large spills may occur and that may submerge the sump area. The viscosity (thickness) of the material and the distance that the material must be pumped are also important considerations. Install pumps according to the manufacturer's recommendations.

An alarm system can be installed for pumps that are used to remove collected materials. An alarm system can indicate that a pump should be operated by hand or that an automatically operated pump has failed to function. Ultimately, facility personnel should have some mechanism to take action to prevent spills from by-passing and overflowing containment structures.

The pumps and the alarm system used in the sump generally require regular inspections for service and maintenance of parts based on manufacturers' recommendations.

If it is possible that the sump may handle combustible or flammable spilled materials, explosion-proof pumping equipment and controls or other appropriate precautions should be taken to prevent explosions or fires. Consult OSHA and local safety codes and standards for specific requirements and guidance.

Advantages of Sumps
• Provide a simple and quick collection method for recycling, reusing, or treating materials in a containment structure • Are commonly used at industrial facilities
Disadvantages of Sumps
• Pumps may clog easily if not designed correctly • May require maintenance/servicing agreements with pump dealers • Costs for purchasing and/or replacing pumps may be high

Covering

What Is It

Covering is the partial or total physical enclosure of materials, equipment, process operations, or activities. Covering certain areas or activities prevents storm water from coming into contact with potential pollutants and reduces material loss from wind blowing. Tarpaulins, plastic sheeting, roofs, buildings, and other enclosures are examples of covering that are effective in preventing storm water contamination. Covering can be temporary or permanent.

When and Where to Use It

Covering is appropriate for outdoor material storage piles (e.g., stockpiles of dry materials, gravel, sand, compost, sawdust, wood chips, de-icing salt, and building materials) and areas where liquids and solids in containers are stored or transferred. Although it may be too expensive to cover or enclose all industrial activities, cover high-risk areas (identified during the storm water pollutant source identification). For example, cover chemical preparation areas, vehicle maintenance areas, areas where chemically treated products are stored, and areas where salts are stored.

If covering or enclosing the entire activity is not possible, the high-risk part of the activity can often be separated from other processes and covered. Another option that reduces the cost of building a complete enclosure is to build a roof over the activity. A roof may also eliminate the need for ventilation and lighting systems (Washington State, 1992).

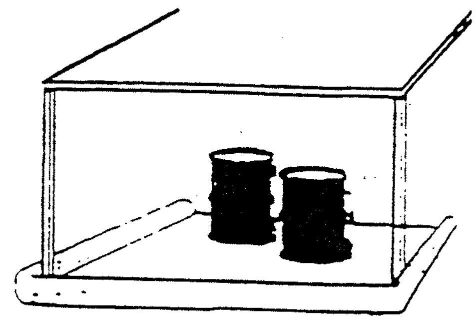
What to Consider

Evaluate the strength and longevity of the covering, as well as its compatibility with the material or activity being enclosed. When designing an enclosure, consider access to materials, their handling, and transfer. Materials that pose environmental and safety dangers because they are radioactive, biological, flammable, explosive, or reactive require special ventilation and temperature considerations.

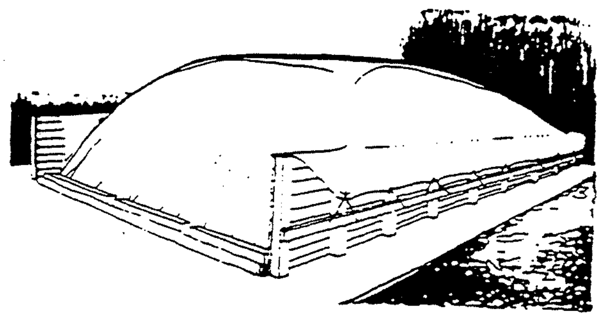
Covering alone may not protect exposed materials from storm water contact. Place the material on an elevated, impermeable surface or build curbing around the outside of the materials to prevent problems from runon of uncontaminated storm water from adjacent areas.

Frequently inspect covering, such as tarpaulins, for rips, holes, and general wear. Anchor the covering with stakes, tie-down ropes, large rocks, tires, or other easily available heavy objects.

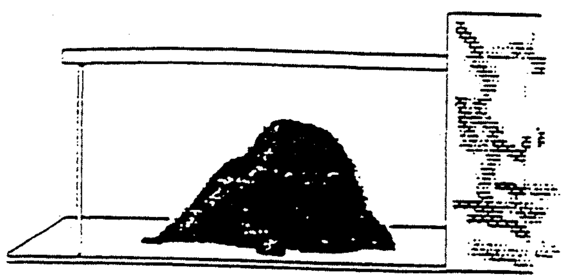
Practicing proper materials management within an enclosure or underneath a covered area is essential. For example, floor drainage within an enclosure should be properly designed and connected to the wastewater sewer where appropriate and allowed. If connection to an offsite wastewater sewer is considered, the local Publicly Owned Treatment Works (POTW) should be consulted to find out if there are any pretreatment requirements or restrictions that must be followed.



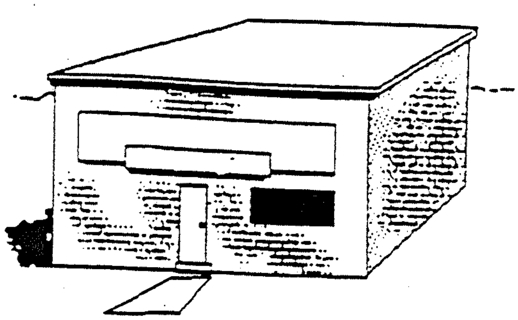
Small Chemical Storage Area with Curbing and Cover



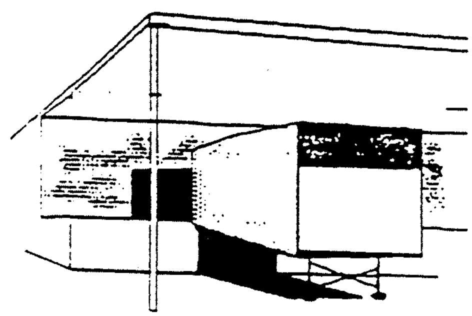
Raw Material Storage Covered with Tarpaulin



Covered Area for Raw Materials



Enclosed Area for Storage of Raw Materials or Chemicals



Covered Area for Loading and Unloading

FIGURE 4.7 EXAMPLE COVERING FOR INDUSTRIAL ACTIVITIES
(Modified from Washington State, 1992; Salt Institute, 1987)

Advantages of Covering
• Is simple and effective • Is commonly inexpensive
Disadvantages of Covering
• Requires frequent inspection • May pose health or safety problems if enclosure is built over certain activities

Vehicle Positioning

What Is It

Vehicle positioning is the practice of locating trucks or rail cars while transferring materials to prevent spills of materials onto the ground surface, which may then contaminate storm water runoff. Vehicle positioning is a simple and effective method of material spill prevention and yet it is commonly overlooked.

When and Where to Use It

Vehicle positioning can be used at all types of industrial facilities. This practice is appropriate for any area where materials are transferred from or to vehicles, such as loading and unloading areas, storage areas, and material transfer areas. Use vehicle positioning in conjunction with other practices such as covering, sumps, drip pans, or loading and unloading by air pressure or vacuum where chemical spills are of concern.

What to Consider

The purpose of vehicle positioning is to locate vehicles in a stable and appropriate position to prevent problems, such as spills resulting from broken material storage containers, spills caused by vehicle movement during materials transfer activities, and spills caused by improperly located vehicles. Vehicles should also be positioned near containment or flow diversion systems to collect unexpected spills from leaks in transfer lines or connections. The following activities are included in this practice:

- Constructing walls that help in positioning the vehicles
- Positioning vehicle either over a drain or on a sloped surface that drains to a containment structure
- Outlining required vehicle positions on the pavement
- Using wheel guards or wheel blocks
- Posting signs requiring the use of emergency brakes
- Requiring vehicles to shut off engines during materials transfer activities.

Advantages of Vehicle Positioning
• Is inexpensive • Is easy and effective
Disadvantages of Vehicle Positioning
• May require redesign of loading and unloading areas

Loading and Unloading by Air Pressure or Vacuum

What Is It

Air pressure and vacuum systems are commonly used for transporting and loading and unloading materials. These systems are simple to use and effective in transferring dry chemicals or solids from one area to another, but are less effective as the particles of material become more dense.

In an air pressure system, a safety-relief valve and a dust collector are used to separate the dry materials from the air and then release the air accumulated during transfer operations. In a vacuum system, a dust collection device and an air lock, such as a rotary gate or trap door feeder, are typically used.

The use of mechanical equipment that involves enclosed lines, such as those provided by air pressure (also referred to as pneumatic) and vacuum loading systems, are effective methods for minimizing releases of pollutants into the environment. Because of the enclosed nature of the system, pollutants are not exposed to wind or precipitation and therefore have less potential to contaminate storm water discharges.

When and Where to Use It

Air pressure and vacuum systems can be used at all types of industrial facilities. This equipment is located in material handling areas to use for storing, loading and unloading, transporting, or conveying materials.

What to Consider

Unlike many of the other BMPs discussed in this manual, air pressure and vacuum systems may be expensive because of the costs of purchasing the system and retrofitting the system to existing materials handling procedures. In many cases, these systems can be shipped to a facility and be installed onsite without contractor help. Manufacturer's recommendations should be followed closely to ensure proper installation. In other cases, systems may have to be designed specifically for a site. Proper design and installation are very important for air pressure and vacuum systems to be as effective as possible. The equipment may be weatherproof or, if not, consider enclosing or covering the equipment.

Conduct routine inspections of air pressure and vacuum systems. Regular maintenance is required of these systems, especially the dust collectors. Conduct maintenance activities based on manufacturers' recommendations. Inspect air pressure systems more frequently due to the greater potential for leaks to the environment.

Advantages of Loading and Unloading by Air Pressure or Vacuum
• Is quick and simple • May be economical if materials can be recovered • Will minimize exposure of pollutants to storm water
Disadvantages of Loading and Unloading by Air Pressure or Vacuum
• May be costly to install and maintain • May not be appropriate for some denser materials • May require site-specific design • Dust collectors may need a permit under the Clean Air Act to install

4.3 MITIGATIVE PRACTICES

Mitigation involves cleaning up or recovering a substance after it has been released or spilled to reduce the potential impact of a spill before it reaches the environment. Therefore, pollution mitigation is a second line of defense where pollution prevention practices have failed or are impractical. Because spills cannot always be avoided at industrial sites, it is necessary to plan for these events and to design proper response procedures. This section discusses mitigative BMPs to avoid contamination of storm water. Most of the mitigative practices discussed are simple and should be incorporated in your facility's good housekeeping and spill response plans. The mitigation practices discussed include manual cleanup methods, such as sweeping and shoveling, mechanical cleanup by excavation or vacuuming, and cleanup with sorbents and gels.

Facilities are cautioned that spills of certain toxic and hazardous substances and their cleanup may be covered under regulations, including those imposed under the Superfund Amendments and Reauthorization Act (SARA), the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA), and the Resource Conservation and Recovery Act (RCRA).

Sweeping

What Is It

Sweeping with brooms, squeegees, or other mechanical devices is used to remove small quantities of dry chemicals and dry solids from areas that are exposed to precipitation or storm water runoff. These areas may include dust or contaminant covered bags, drums containing remaining materials on their lids, areas housing enclosed or covered materials, and spills of dry chemicals and dry solids in locations on the industrial site. Cleaning by sweeping with brooms is a low cost practice that can be performed by all employees and requires no special equipment or training.

When and Where to Use It

Sweeping can be used at many material handling areas and process areas in all types of industrial facilities. Timing is an important consideration for all mitigative practices. To be effective as a storm water control, cleanup must take place before rainfall or contact with storm water runoff or before an outside area is hosed down.

Do not limit your cleanup activities to those outside activities that are exposed to rainfall. In many cases, tracking of materials to the outside from areas that are enclosed or covered (e.g., on shoes) may also occur.

What to Consider

Store brooms appropriately and do not expose them to precipitation. In addition, rules of compatibility also apply. Do not use the same broom to clean up two chemicals that are incompatible. Determine the compatibility between the brooms themselves and the chemical of concern before using this practice. In some instances, chemicals should be vacuumed instead of swept. Be sure that swept material is disposed of properly.

Advantages of Sweeping
• Is inexpensive • Requires no special training • Provides recycling opportunities
Disadvantages of Sweeping
• Is a labor-intensive practice • Is limited to small releases of dry materials

Shoveling

What Is It

Shoveling is another manual cleanup method that is simple and low in cost. Generally, shoveling can be used to remove larger quantities of dry chemicals and dry solids, as well as to remove wetter solids and sludge. Shoveling is also useful in removing accumulated materials from sites not accessible by mechanical cleanup methods.

When and Where to Use It

Shoveling can be used at any facility. Shoveling provides an added advantage over sweeping because cleanup methods are not limited to dry materials. In many cases, accumulated solids and sludges that are in ditches, sumps, or other facility locations can be effectively and quickly removed by shoveling.

Shovels can also be used to clean up contaminated snows. Timing is an important consideration in any mitigative practice. Materials that could contaminate storm water runoff should be removed before any storm event.

What to Consider

As with brooms, clean and store shovels properly. Also, consider planning for the transport and disposal or reuse of the shoveled materials.

Advantages of Shoveling
• Is inexpensive
• Provides recycling opportunities
• Can remediate larger releases and is effective for dry and wet materials
Disadvantages of Shoveling
• Is labor-intensive
• Is not an appropriate practice for large spills

Excavation Practices

What Are They

Excavation (i.e., removal of contaminated material) of released materials is typically conducted by mechanical equipment, such as plows and backhoes. Generally, plowing and backhoeing can be done using a specifically designed vehicle, tractor, or truck.

Excavation removes the materials of concern and any deposition of contaminants, thereby reducing the potential for storm water contamination. Mechanical cleanup methods are typically less precise than manual cleanup methods, resulting in reduced opportunities for recycle and reuse.

When and Where to Use Them

Excavation practices are most useful for large releases of dry materials and for areas contaminated by liquid material releases. In excavation, you want to be sure that all of the contaminated material is removed.

Timing is an important consideration for all mitigative practices. To be effective as a storm water control, cleanup must take place before a rainfall event.

What to Consider

Conduct inspections and operations and maintenance in accordance with a manufacturer's recommendations, which may include the following:

- A specified frequency for inspection, maintenance, and servicing of the equipment
- Parts replacement, rotation, and lubrication specifications
- Procedures for evaluating all parts.

As with any equipment used during cleanup, other considerations apply, including the following:

- Plows, backhoes, etc. should be stored appropriately with no exposure to precipitation
- Excavated materials should be properly handled or disposed of.

Advantages of Excavation Practices
• Are a cost effective method for cleaning up dry materials release • Are common and simple
Disadvantages of Excavation Practices
• Are less precise, resulting in less recycling and reuse opportunities

Vacuum and Pump Systems

What Are They

Vacuum and pump systems are effective for cleaning up spilled or exposed materials.

The benefits of vacuum and pump cleanup systems include simplicity and speed. With such systems, only the spilled materials need be collected. Also, these systems are often portable and can be used at many locations to clean up releases to the environment. Portable systems can usually be rented.

When and Where to Use Them

Vacuum and pump systems can be used at any industrial facility. Both wet and dry materials can be collected with these systems. Vacuum systems can be used in material handling areas and process areas.

What to Consider

Consider the area of use and the most appropriate size for the system. Since these systems can be portable, size is important, especially if materials will be stored in the unit. In this case, the portable system must have enough suction or positive air pressure to transport materials over long distances. Include plans for proper disposal or reuse of the collected materials.

Advantages of Vacuum and Pump Systems
• Remove materials by air pressure or vacuum quickly and simply • Collect materials accurately • Offer good recycling opportunities
Disadvantages of Vacuum and Pump Systems
• May require high initial capital cost • Require equipment maintenance

Sorbents

What Are They

Sorbents are materials that are capable of cleaning up spills through the chemical processes of adsorption and absorption. Sorben^{--} adsorb (an attraction to the outer surface of a material) or absorb (taken in by the material like a sponge) only when they come in contact with the sorbent materials. The sorbents must be mixed with a spill or the liquid must be passed through the sorbent. Sorbent materials come in many different forms from particles to foams. Often the particles are held together in structures called booms, pads, or socks. Sorbents include, but are not limited to, the following:

- **Common Materials (clays, sawdust, straw, and flyash)**—Generally come in small particles that can be thrown onto a spill that is on a surface. The materials absorb the spill by taking up the liquid.

- **Polymers (polyurethane and polyolefin)**—Come in the form of spheres, beads, or foam tablets. These materials absorb a chemical spill by taking up the liquid into their open-pore structure.

- **Activated Carbon**—Comes in a powdered or granular form and can be mixed with liquids to remove pollutants. This sorbent works by adsorbing the organics to its surface and can be recycled and then reused by a process called regeneration.

- **"Universal Sorbent Material"**—Is a silicate glass foam consisting of rounded particles that can absorb the material.

When and Where to Use Them

Sorbents are useful BMPs for facilities with liquid materials onsite. Timing is important for these practices. To be effective as a storm water BMP, cleanup must take place before a rainfall. Sorbents are often used in conjunction with curbing to provide cleanup of small spills within a containment area.

"Universal Sorbent Materials" are suitable for use on many compounds including acids, alkalis, alcohols, aldehydes, arsenate, ketones, petroleum products, and chlorinated solvents.

Activated carbon is useful for adsorbing many organic compounds. Organics that are diluted in water can be passed through a column that is filled with the activated carbon material to remove the organics, or the activated carbon can be mixed into the water and can then be filtered out.

Polyurethane is good with chemical liquids such as benzene, chlorinated solvents, epicholorhydrin, and phenol. Polyolefin is used to remove organic solvents, such as phenol and various chlorinated solvents. The beads and spheres are usually mixed into a spill by use of a blower and then are skimmed from the top surface by use of an oil boom.

More common materials such as clay, sawdust, straw, and fly-ash can be used for a liquid spill on a surface that is relatively impenetrable, and are usually spread over the spill area with shovels.

Booms, pads, and socks are also useful in areas where there are small liquid spills or drips or where small amounts of solids may mix with small amounts of storm water runoff. They can function both to absorb the pollutants from the storm water and restrict the movement of a spill. Socks are often used together with curbing to clean up small spills.

What to Consider

Because sorbents work by a chemical or physical reaction, some sorbents are better than others for certain types of spills. Therefore, the use of sorbents requires that personnel know the properties of the spilled material(s) to know which sorbent is appropriate. To be effective, sorbents must adsorb the material spilled but must not react with the spilled material to form hazardous or toxic substances. Follow the manufacturers' recommendations.

For sorbents to be effective, they must be applied immediately in the release area. The use of sorbent material is generally very simple: the sorbent is added to the area of release, mixed well, and allowed to adsorb or absorb. Many sorbents are not reusable once they have been used. Proper disposal is required.

Advantages of Sorbents
• Work in water environments (booms and socks) • Offer recycling opportunities (some types of sorbents)
Disadvantages of Sorbents
• Require a knowledge of the chemical makeup of a spill (to choose the best sorbent) • Offer no recycling opportunities (some types of sorbents) • May be expensive practice for large spills • May create disposal problems and increase disposal costs by creating a solid waste and potentially a hazardous waste.

Gelling Agents

What Are They

Gelling agents are materials that interact with liquids either physically or chemically (i.e., thickening or polymerization). Some of the typical gelling agents are polyelectrolytes, polyacrylamide, butylstyrene copolymers, polyacrylonitrile, polyethylene oxide, and a gelling agent referred to as the universal gelling agent which is a combination of these synthetics.

Gelling interacts with a material by concentrating and congealing it to become semisolid. The semisolid gel later forms a solid material, which can then be cleaned up by manual or mechanical methods. The BMP of using a gelling agent is one of the few ways to effectively control a liquid spill before it reaches a receiving water or infiltrates into the soil and then ground water.

When and Where to Use Them

Gelling agents are useful for facilities with significant amounts of liquid materials stored onsite. Gels cannot be used to clean up spills on surface water unless authorized by the U.S. Coast Guard or EPA Regional Response Team.

What to Consider

Gels can be used to stop the liquid's flow on land, prevent its seeping into the soil, and reduce the surface spreading of a spill. Because of these properties, gels can reduce the need for extensive cleanup methods and reduce the possibility of storm water contamination from an uncontrolled industrial spill. As with sorbents, the use of gels simply involves the addition of the gel to the area of the spill, mixing well, and allowing the mass to congeal. To use gels correctly, however, personnel need to know the properties of the spilled materials so that they can choose the correct gel.

Timing is particularly important for gelling agent use. To prevent the movement of materials, gelling agents must be applied immediately after the spill. The use of gelling agents results in a large bulk of congealed mass that usually cannot be separated. Ultimately, this mass will need to be cleaned up by manual or mechanical methods and disposed of properly.

Advantages of Gelling Agents
• Stop the movement of spilled or released liquid materials • Require no permanent structure
Disadvantages of Gelling Agents
• May require knowledge of the spilled materials to select correct gelling agents • Usually offer no recycling opportunities • May be difficult to clean up • May create disposal problems and increase disposal costs by creating a solid waste and potentially a hazardous waste

4.4 OTHER PREVENTIVE PRACTICES

A number of preventive measures can be taken at industrial sites to limit or prevent the exposure of storm water runoff to contaminants. This section describes a few of the most easily implemented measures:

- Preventive Monitoring Practices
- Dust Control (Land Disturbance and Demolition Areas)
- Dust Control (Industrial)
- Signs and Labels
- Security
- Area Control Procedures
- Vehicle Washing.

Preventive Monitoring Practices

What Are They

Preventive monitoring practices include the routine observation of a process or piece of equipment to ensure its safe performance. It may also include the chemical analysis of storm water before discharge to the environment.

When and Where to Use Them

Automatic Monitoring System—In areas where overflows, spills, and catastrophic leaks are possible, an automatic monitoring system is recommended. Some Federal, State, and local laws require such systems to be present if threats exist to the health and safety of personnel and the environment. For material management areas, monitoring may include liquid level detectors, pressure and temperature gauges, and pressure-relief devices. In material transfer, process, and material handling areas, automatic monitoring systems can include pressure drop shutoff devices, flow meters, thermal probes, valve position indicators, and operation lights. Loading and unloading operations might use these devices for measuring the volume of tanks before loading, for weighing vehicles or containers, and for determining rates of flow during loading and unloading.

Automatic Chemical Monitoring—Measures the quality of plant runoff to determine whether discharge is appropriate or whether diversion to a treatment system is warranted. Such systems might monitor pH, turbidity, or conductivity. These parameters might be monitored in diked areas, sewers, drainage ditches, or holding ponds. Systems can also be designed to signal automatic diversion of contaminated storm water runoff to a holding pond (e.g., a valve or a gate could be triggered by a certain pollutant in the storm water runoff).

Manned Operations—In material transfer areas and process areas, personnel can be stationed to watch over the operations so that any spills or mismanagement of materials can be corrected immediately. This is particularly useful at loading and unloading areas where vehicles or equipment must be maneuvered into the proper position to unload (see Vehicle Positioning BMP).

Nondestructive Testing—Some situations require that a storage tank or a pipeline system be tested without being physically moved or disassembled. The structural integrity of tanks, valves, pipes, joints, welds, and other equipment can be tested using nondestructive methods. Acoustic emission tests use high frequency sound waves to draw a picture of the structure to reveal cracks, malformations, or other structural damage. Another type of testing is hydrostatic pressure testing. During pressure testing, the tank or pipe is subjected to pressures several times the normal pressure. A loss in pressure during the testing may indicate a leak or some other structural damage. Tanks and containers should be pressure tested as required by Federal, State, or local regulations.

What to Consider

Automated monitoring systems should be placed in an area where plant personnel can easily observe the measurements. Alarms can be used in conjunction with the measurement display to warn personnel. Manned operations should have communication systems available for getting help in case spills or leaks occur. Especially sensitive or spill-prone areas may require back-up instrumentation in case the primary instruments malfunction.

Mechanical and electronic equipment should be operated and maintained according to the manufacturers' recommendations. Equipment should be inspected regularly to ensure proper and accurate operation.

The pollution prevention team, in consultation with a certified safety inspector, should evaluate system monitoring requirements to decide which systems are appropriate based on hazard potential.

Advantages of Preventive Monitoring Practices
• Pressure and vacuum testing can locate potential leaks or damage to vessels early. The primary benefit of such testing is in ensuring the safety of personnel, but it also has secondary benefits including prevention of storm water contamination. • Automatic system monitors allow for early warnings if a leak, overflow, or catastrophic incident is imminent. • Manning operations, especially during loading and unloading activities, is effective and generally inexpensive. • The primary benefit of nondestructive testing is in ensuring the safety of personnel, but it also has secondary benefits including early detection of the potential for contaminating storm water runoff.
Disadvantages of Preventive Monitoring Practices
• Plant personnel often do not have the expertise to maintain automatic equipment. • Automatic equipment can fail without warning. • Automated process control and monitoring equipment may be expensive to purchase and operate

Dust Control (Land Disturbance and Demolition Areas)

What Is It

Dust controls for land disturbance and demolition areas are any controls that reduce the potential for particles being carried through air or water. Types of dust control are:

- **Irrigation**—Irrigation is a temporary measure involving a light application of water to moisten the soil surface. The process should be repeated as necessary.

- **Minimization of Denuded Areas**—Minimizing soil exposure reduces the amount of soil available for transport and erosion. Soil exposure can be lessened by temporary or permanent soil stabilization controls, such as seeding, mulching, topsoiling, crushed stone or coarse gravel spreading, or tree planting. Maintaining existing vegetation on a site will also help control dust.

- **Wind Breaks**—Wind breaks are temporary or permanent barriers that reduce airborne particles by slowing wind velocities (slower winds do not suspend particles). Leaving existing trees and large shrubs in place will create effective wind breaks. More temporary types of wind breaks are solid board fences, snow fences, tarp curtains, bales of hay, crate walls, and sediment walls.
- **Tillage**—Deep plowing will roughen the soil surface to bring up to the surface cohesive clods of soil, which in turn rest on top of dusts, protecting them from wind and water erosion. This practice is commonly practiced in arid regions where establishing vegetation may take time.

- **Chemical Soil Treatments (palliatives)**—These are temporary controls that are applied to soil surfaces in the form of spray-on adhesives, such as anionic asphalt emulsion, latex emulsion, resin-water emulsions, or calcium chloride. The palliative is the chemical used. These should be used with caution as they may create pollution if not used correctly.

When and Where to Use It

Dust controls can be used on any site where dust may be generated and where the dust may cause onsite and offsite damage. Dust controls are especially critical in arid areas, where reduced rainfall levels expose soil particles for transport by air and runoff. This control should be used in conjunction with other sedimentation controls such as sediment traps.

What to Consider

To control dust during land disturbance and at demolition areas, exposure of soil should be limited as much as possible. When possible, work that causes soil disturbance or involves demolition should be done in phases and should be accompanied by temporary stabilization measures. These precautions will minimize the amount of soil that is disturbed at any one time and, therefore, control dust.

Oil should not be used to control dust because of its high potential for polluting storm water discharges.

Irrigation will be most effective if site drainage systems are checked to ensure that the right amount of water is used. Too much water can cause runoff problems.

Chemical treatment is only effective on mineral soils, as opposed to muck soils, because the chemicals bond better to mineral soils. Therefore, it should be used only in arid regions. Vehicular traffic should be routed around chemically treated areas to avoid tracking of the chemicals. Certain chemicals may be inappropriate for some types of soils or application areas. For example, spraying chemicals on the soil of an industrial site adjacent to a school may be dangerous. Local governments usually have information about restrictions on the types of palliatives that may be used. Special consideration must be given to preserving ground water quality whenever chemicals are applied to the land.

Since most of these techniques are temporary controls, sites should be inspected often and materials should be reapplied when needed. The frequency for these inspections depends on site-specific conditions, weather conditions, and the type of technique used.

Advantages of Dust Control (Land Disturbance and Demolition Areas)
• Can help prevent wind-and-water based erosion of disturbed areas and will reduce respiratory problems in employees • Some types can be implemented quickly at low cost and effort (except wind breaks) • Helps preserve the aesthetics of the site and screens certain activities from view (wind breaks) • Vegetative wind breaks are permanent and an excellent alternative to chemical use

Disadvantages of Dust Control (Land Disturbance and Demolition Areas)
• Some types are temporary and must be reapplied or replenished regularly • Some types are expensive (irrigation and chemical treatment) and may be ineffective under certain conditions • May result in health and/or environmental hazards, e.g., if overapplication of the chemicals leaves large amounts exposed to wind and rain erosion or ground water contamination • May create excess runoff that the site was not designed to control (irrigation) • May cause increased offsite tracking of mud (irrigation) • Is not as effective as chemical treatment or mulching and seeding; requires land space that may not be available at all locations (wind breaks)

Dust Control (Industrial)

What Is It

Dust controls for material handling areas are controls that prevent pollutants from entering storm water discharges by reducing the surface and air transport of dust caused by industrial activities. Consider the following types of controls:

- Water spraying
- Negative pressure systems (vacuum systems)
- Collector systems (bag and cyclone)
- Filter systems
- Street sweeping.

The purpose of industrial dust control is to collect or contain dusts to prevent storm water runoff from carrying the dusts to the sewer collection system or to surface waters.

When and Where to Use It

Dust control is useful in any process area, loading and unloading area, material handling areas, and transfer areas where dust is generated. Street sweeping is limited to areas that are paved.

What to Consider

Mechanical dust collection systems are designed according to the size of dust particles and the amount of air to be processed. Manufacturers' recommendations should be followed for installation (as well as the design of the equipment).

If water sprayers are used, dust-contaminated waters should be collected and taken for treatment. Areas will probably need to be resprayed to keep dust from spreading.

Two kinds of street sweepers are common: brush and vacuum. Vacuum sweepers are more efficient and work best when the area is dry.

Mechanical equipment should be operated according to the manufacturers' recommendations and should be inspected regularly.

Advantages of Dust Control (Industrial)
• May cause a decrease of respiratory problems in employees around the site • May cause less material to be lost and may therefore save money • Provides efficient collection of larger dust particles (street sweepers)

Disadvantages of Dust Control (Industrial)
• Is generally more expensive than manual systems • May be impossible to maintain by plant personnel (the more elaborate equipment) • Is labor and equipment intensive and may not be effective for all pollutants (street sweepers)

Signs and Labels

What Are They

Signs and labels identify problem areas or hazardous materials at a facility. Warning signs, often found at industrial facilities, are a good way to suggest caution in certain areas. Signs and labels can also provide instructions on the use of materials and equipment. Labelling is a good way to organize large amounts of materials, pipes, and equipment, particularly on large sites.

Labels tell material type and container contents. Accurate labeling can help facilities to quickly identify the type of material released so facility personnel can respond correctly.

Two effective labeling methods include color coding and Department of Transportation (DOT) labeling. Color coding is easily recognized by facility personnel and simply involves painting/coating or applying an adhesive label to the container. Color codes must be consistent throughout the facility to be effective, and signs explaining the color codes should be posted in all areas.

DOT requires that labels be prominently displayed on transported hazardous and toxic materials. Labeling required by DOT could be expanded to piping and containers, making it easy to recognize materials that are corrosive, radioactive, reactive, flammable, explosive, or poisonous.

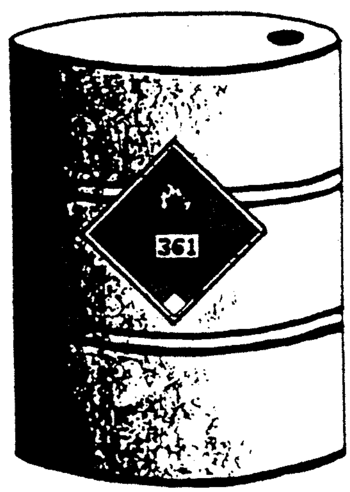


FIGURE 4.8 SIGN ON DRUM INDICATING FLAMMABILITY

When and Where to Use Them

Signs and labels can be used at all types of facilities. Areas where they are particularly useful are material transfer areas, equipment areas, loading and unloading areas, or anywhere information might prevent contaminants from being released to storm water.

What to Consider

Signs and labels should be visible and easy to read. Useful signs and labels might provide the following information:

- Names of facility and regulatory personnel, including emergency phone numbers, to contact in case of an accidental discharge, spill, or other emergency
- Proper uses of equipment that could cause release of storm water contaminants
- Types of chemicals used in high-risk areas
- The direction of drainage lines/ditches and their destination (treatment or discharge)
- Information on a specific material
- Refer to OSHA standards for sizes and numbers of signs required for hazardous material labeling.

Hazardous chemicals might be labeled as follows:

- Danger
- Combustible
- Warning
- Caution
- Flammable
- Poisonous
- Caustic
- Corrosive
- Volatile
- Explosive

Periodic checks can ensure that signs are still in place and labels are properly attached. Signs and labels should be replaced and repaired as often as necessary.

Advantages of Signs and Labels
• Are inexpensive and easily used
Disadvantages of Signs and Labels
• Must be updated and maintained so they are legible

Security

What Is It

Setting up a security system as part of your Plan could help prevent an accidental or intentional release of materials to storm water runoff as a result of vandalism, theft, sabotage, or other improper uses of facility property. If your facility already has a security system, consider improving it by training security personnel about the specifics of the Storm Water Pollution Prevention Plan. Routine patrol, lighting, and access control are discussed below as possible measures to include in your facility's security system.

When and Where to Use It

Routine patrol, lighting, and access control are measures that can be used at any facility.

What to Consider

Security information could be included in the existing training required by the Plan to instruct personnel about where and how to patrol areas within the facility. Instruction might also include what to look for in problem areas and how to respond to problems. During routine patrol, security personnel can actively search the facility site for indications of spills, leaks, or other discharges; respond to any disturbance resulting from intruders or inappropriate facility operations; and generally work as a safeguard to prevent unexpected events. Routine patrols could be an effective part of the Storm Water Pollution Prevention Plan, especially for large facilities with established security measures. To make this practice effective, security personnel can help develop the Storm Water Pollution Prevention Plan, possibly with one person acting as a member of the pollution prevention committee.

Sufficient lighting throughout the facility during daytime and night hours will make it easier to get to equipment during checks and will make it easy to detect spills and leaks that might otherwise be hidden. Routine patrols are also easier with proper lighting.

Controlling access to the industrial site is an important part of plant security and of activity and traffic control. Signs, fencing, guard houses, dog patrols, and visitor clearance requirements are often used to control site access.

- Signs are the simplest, most inexpensive method of access control, but they are limited in their actual control since they provide no physical barriers and require that people obey them voluntarily.
- Fencing provides a physical barrier to the facility site and an added means of security.
- Guard houses used with visitor rules can help to ensure that only authorized personnel enter the facility site and can limit vehicular traffic as well.
- Traffic signs are also useful at facility sites. Restricting vehicles to paved roads and providing direction and warning signs can help prevent accidents. Where restricting vehicles to certain pathways is not possible, it is important to ensure that all above-ground valves and pipelines are well marked.

Advantages of Security
• Provides a preventive safeguard to operational malfunctions or other facility disturbances (routine patrols)
• Allows easier detection of vandals or thieves (lighting)
• Allows easier detection of spills, leaks, or other releases (lighting)
• Prevents spills by providing good visibility (lighting)
• Prevents unauthorized access to facility (access control)

Disadvantages of Security
• May not be feasible for smaller facilities
• May be costly (e.g., installation of lighting systems)
• May increase energy costs as a result of additional lighting
• May not be feasible to have extensive access controls at smaller facilities

Area Control Procedures

What Are They

The activities conducted at an industrial site often result in the materials being deposited on clothes and footwear and the being carried throughout the facility site. As a result, these materials may find their way into the storm water runoff.

Area control procedures involve practicing good housekeeping measures such as maintaining indoor or covered material storage and industrial processing areas. If the area is kept clean, the risk of accumulating materials on footwear and clothing is reduced. In turn, the chance of left over pollutants making contact with storm water and polluting surface water is minimized.

When and Where to Use Them

Area control measures can be used at any facility where materials may be tracked into areas where they can come in contact with storm water runoff. Areas can include material handling areas, storage areas, or process areas.

What to Consider

Materials storage areas and industrial processing areas should be checked regularly to ensure that good housekeeping measures are being implemented. Cover-garments, foot mats, and other devices used to collect residual material near the area should be cleaned regularly.

Other effective practices include the following:

- Brushing off clothing before leaving the area
- Stomping feet to remove material before leaving the area
- Using floor mats at area exits
- Using coveralls, smocks, and other overgarments in areas where exposure to material is of greatest concern (employees should remove the overgarments before leaving the area)
- Posting signs to remind employees about these practices.

Advantages of Area Control Procedures
• Are easy to implement • Result in a cleaner facility and improved work environment
Disadvantage of Area Control Procedures
• May be seen as tedious by employees and therefore may not be followed

Vehicle Washing

What Is It

Materials that accumulate on vehicles and then scatter across industrial sites represent an important source of storm water contamination. Vehicle washing removes materials such as site-specific dust and spilled materials that have accumulated on the vehicle. If not removed, residual material will be spread by gravity, wind, snow, or rainfall as the vehicles move across the facility site and off the site.

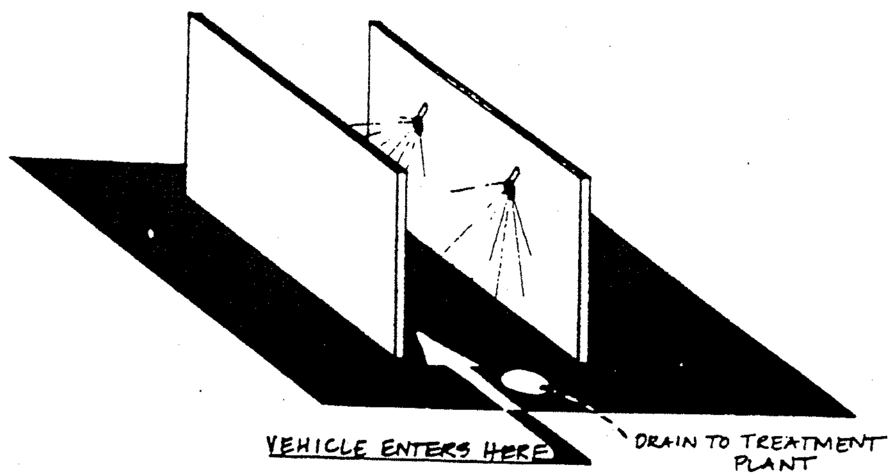


FIGURE 4.9 TRUCK WASHING AREA

When and Where to Use It

This practice is appropriate for any facility where vehicles come into contact with raw materials on a site. If possible, the vehicle washing area should be built near the location where the most vehicle activity occurs. Wastewater from vehicle washing should be directed away from process materials to prevent contact. Those areas include material transfer areas, loading and unloading areas, or areas located just before the site exit.

What to Consider

When considering the method of vehicle washing, the facility should consider using a high-pressure water spray with no detergent additives. In general, water will adequately remove contaminants from the vehicle. If detergents are used, they may cause other environmental impacts. Phosphate- or organic-containing compounds should be avoided.

If this practice is considered, truck wash waters will result in a non-storm water discharge, thus requiring an application for an NPDES permit to cover the discharge.

Blowers or vacuums should be considered where the materials are dry and easily removed by air.

Advantages of Vehicle Washing
• Prevents dispersion of materials across the facility site • Is necessary only where methods for transferring contained materials and minimizing exposure have not been successfully adopted and implemented
Disadvantages of Vehicle Washing
• May be costly to construct a truck washing facility

4.5 SEDIMENT AND EROSION PREVENTION PRACTICES

Any site where soils are exposed to water, wind or ice can have soil erosion and sedimentation problems. Erosion is a natural process in which soil and rock material is loosened and removed. Sedimentation occurs when soil particles are suspended in surface runoff or wind and are deposited in streams and other water bodies.

Human activities can accelerate erosion by removing vegetation, compacting or disturbing the soil, changing natural drainage patterns, and by covering the ground with impermeable surfaces (pavement, concrete, buildings). When the land surface is developed or "hardened" in this manner, storm water and snowmelt can not seep into or "infiltrate" the ground. This results in larger amounts of water moving more quickly across a site which can carry more sediment and other pollutants to streams and rivers.

EPA's General Permit requires that all industries identify in their Storm Water Pollution Prevention Plans areas that may have a high potential for soil erosion. This includes areas with such heavy activity that plants cannot grow, soil stockpiles, stream banks, steep slopes, construction areas, demolition areas, and any area where the soil is disturbed, denuded (stripped of plants), and subject to wind and water erosion. EPA further requires that you take steps to limit this erosion.

There are seven ways to limit and control sediment and erosion on your site:

- Leave as much vegetation (plants) onsite as possible.
- Minimize the time that soil is exposed.
- Prevent runoff from flowing across disturbed areas (divert the flow to vegetated areas).
- Stabilizing the disturbed soils as soon as possible.
- Slow down the runoff flowing across the site.
- Provide drainage ways for the increased runoff (use grassy swales rather than concrete drains).
- Remove sediment from storm water runoff before it leaves the site.

Using these measures to control erosion and sedimentation is an important part of storm water management. Selecting the best set of sediment and erosion prevention measures for your industry depends upon the nature of the activities on your site (i.e., how much construction or land disturbance there is) and other site-specific conditions (soil type, topography, climate, and season). Section 4.5.1 discusses some temporary and permanent ways to stabilize your site. Section 4.5.2 describes more structural ways to control sediment and erosion.

In some arid regions, growing vegetation to prevent erosion may be difficult. The local Soil Conservation Service Office or County Extension Office can provide information on any special measures necessary to promote the establishment of vegetation.

4.5.1 Vegetative Practices

Preserving existing vegetation or revegetating disturbed soil as soon as possible after construction is the most effective way to control erosion. A vegetation cover reduces erosion potential in four ways: (1) by shielding the soil surface from direct erosive impact of raindrops; (2) by improving the soil's water storage porosity and capacity so more water can infiltrate into the ground; (3) by slowing the runoff and allowing the sediment to drop out or deposit; and (4) by physically holding the soil in place with plant roots.

Vegetative cover can be grass, trees, shrubs, bark, mulch, or straw. Grasses are the most common type of cover used for revegetation because they grow quickly, providing erosion protection within days. Other soil stabilization practices such as straw or mulch may be used during non-growing seasons to prevent erosion. Newly planted shrubs and trees establish root systems more slowly, so keeping existing ones is a more effective practice.

Vegetative and other site stabilization practices can be either temporary or permanent controls. Temporary controls provide a cover for exposed or disturbed areas for short periods of time or until permanent erosion controls are put in place. Permanent vegetative practices are used when activities that disturb the soil are completed or when erosion is occurring on a site that is otherwise stabilized. The remainder of this section describes the common vegetative practices listed below:

- Preservation of Natural Vegetation
- Buffer Zones
- Stream Bank Stabilization
- Mulching, Matting, and Netting
- Temporary Seeding
- Permanent Seeding and Planting
- Sodding
- Chemical Stabilization.

Preservation of Natural Vegetation

What Is It

The preservation of natural vegetation (existing trees, vines, brushes, and grasses) provides natural buffer zones. By preserving stabilized areas, it minimizes erosion potential, protects water quality, and provides aesthetic benefits. This practice is used as a permanent control measure.

When and Where to Use It

This technique is applicable to all types of sites. Areas where preserving vegetation can be particularly beneficial are floodplains, wetlands, stream banks, steep slopes, and other areas where erosion controls would be difficult to establish, install, or maintain.

What to Consider

Preservation of vegetation on a site should be planned before any site disturbance begins. Preservation requires good site management to minimize the impact of construction activities on existing vegetation. Clearly mark the trees to be preserved and protect them from ground disturbances around the base of the tree. Proper maintenance is important to ensure healthy vegetation that can control erosion. Different species, soil types, and climatic conditions will require different maintenance activities such as mowing, fertilizing, liming, irrigation, pruning, and weed and pest control. Some State/local regulations require natural vegetation to be preserved in sensitive areas; consult the appropriate State/local agencies for more information on their regulations. Maintenance should be performed regularly, especially during construction.

Advantages of Preservation of Natural Vegetation
• Can handle higher quantities of storm water runoff than newly seeded areas • Does not require time to establish (i.e., effective immediately) • Increases the filtering capacity because the vegetation and root structure are usually denser in preserved natural vegetation than in newly seeded or base areas • Enhances aesthetics • Provides areas for infiltration, reducing the quantity and velocity of storm water runoff • Allows areas where wildlife can remain undisturbed • Provides noise buffers and screens for onsite operations • Usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation
Disadvantages of Preservation of Natural Vegetation
• Requires planning to preserve and maintain the existing vegetation • May not be cost effective with high land costs • May constrict area available for construction activities

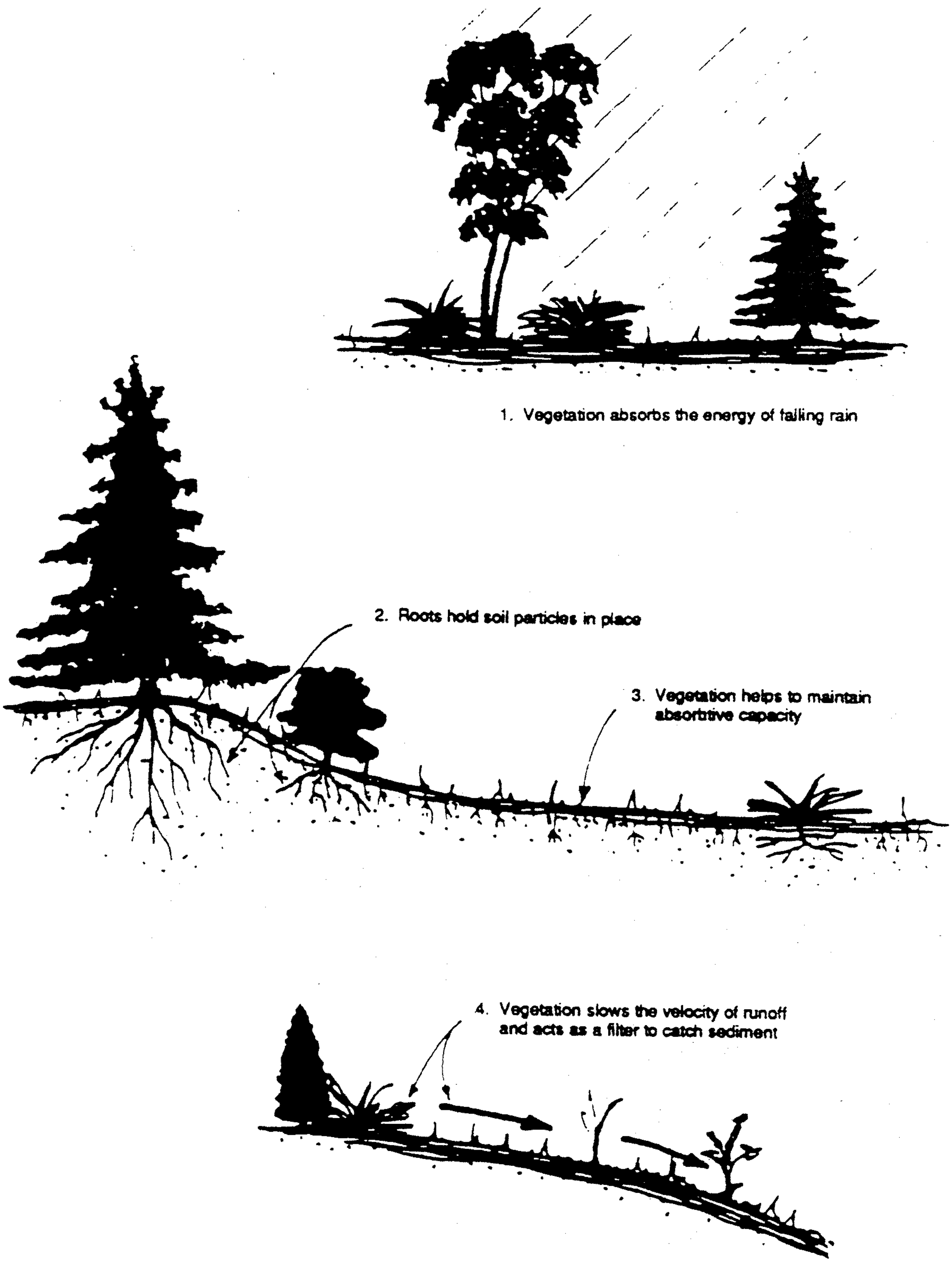


FIGURE 4.10 BENEFITS OF PRESERVING NATURAL VEGETATION
(Modified from Washington State, 1992)

Buffer Zones

What Are They

Buffer zones are vegetated strips of land used for temporary or permanent water quality benefits. Buffer zones are used to decrease the velocity of storm water runoff, which in turn helps to prevent soil erosion. Buffer zones are different from vegetated filter strips (see section on Vegetated Filter Strips) because buffer zone effectiveness is not measured by its ability to improve infiltration (allow water to go into the ground). The buffer zone can be an area of vegetation that is left undisturbed during construction, or it can be newly planted.

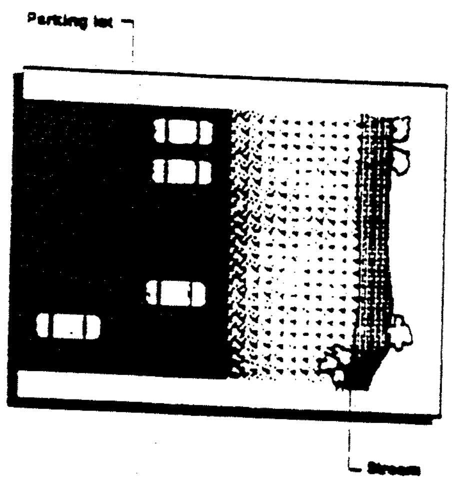


FIGURE 4.11 EXAMPLE BUFFER ZONE
(Modified from Washington State, 1992)

When and Where to Use Them

Buffer zones technique can be used at any site that can support vegetation. Buffer zones are particularly effective on floodplains, next to wetlands, along stream banks, and on steep, unstable slopes.

What to Consider

If buffer zones are preserved, existing vegetation, good planning, and site management are needed to protect against disturbances such as grade changes, excavation, damage from equipment, and other activities. Establishing new buffer strips requires the establishment of a good dense turf, trees, and shrubs (see Permanent Seeding and Planting). Careful maintenance is important to ensure healthy vegetation. The need for routine maintenance such as mowing, fertilizing, liming, irrigating, pruning, and weed and pest control will depend on the species of plants and trees involved, soil types, and climatic conditions. Maintaining planted areas may require debris removal and protection against unintended uses or traffic. Many State/local storm water program or zoning agencies have regulations which define required or allowable buffer zones especially near sensitive areas such as wetlands. Contact the appropriate State/local agencies for their requirements.

Advantages of Buffer Zones
• Provide aesthetic as well as water quality benefits • Provide areas for infiltration, which reduces amount and speed of storm water runoff • Provide areas for wildlife habitat • Provide areas for recreation • Provide buffers and screens for onsite noise if trees or large bushes are used • Low maintenance requirements • Low cost when using existing vegetation
Disadvantages of Buffer Zones
• May not be cost effective to use if the cost of land is high • Are not feasible if land is not available • Require plant growth before they are effective

Stream Bank Stabilization

What Is It

Stream bank stabilization is used to prevent stream bank erosion from high velocities and quantities of storm water runoff. Typical methods include the following:

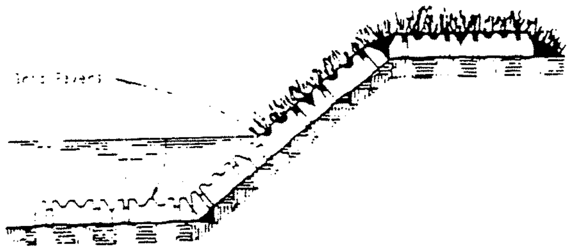
- **Riprap**–Large angular stones placed along the stream bank or lake
- **Gabion**–Rock-filled wire cages that are used to create a new stream bank
- **Reinforced Concrete**–Concrete bulkheads and retaining walls that replace natural stream banks and create a nonerosive surface
- **Log Cribbing**–Retaining walls built of logs to anchor the soils against erosive forces. Usually built on the outside of stream bends
- **Grid Pavers**–Precast or poured-in-place concrete units that are placed along stream banks to stabilize the stream bank and create open spaces where vegetation can be established
- **Asphalt**–Asphalt paving that is placed along the natural stream bank to create a nonerosive surface.

When and Where to Use It

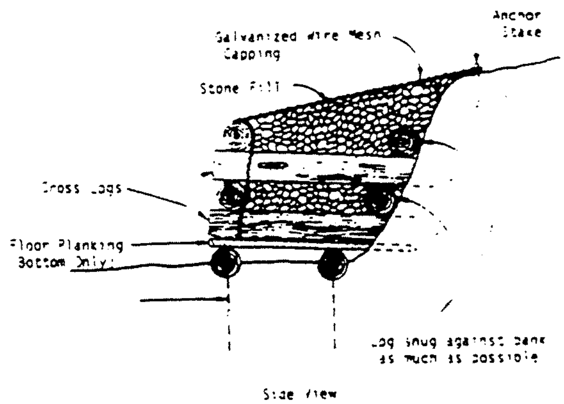
Stream bank stabilization is used where vegetative stabilization practices are not practical and where the stream banks are subject to heavy erosion from increased flows or disturbance during construction. Stabilization should occur before any land development in the watershed area. Stabilization can also be retrofitted when erosion of a stream bank occurs.

What to Consider

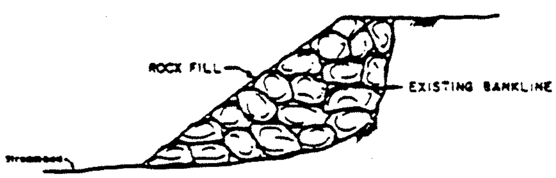
Stream bank stabilization structures should be planned and designed by a professional engineer licensed in the State where the site is located. Applicable Federal, State, and local requirements should be followed, including Clean Water Act Section 404 regulations. An important design feature of stream bank stabilization methods is the foundation of the structure; the potential for the stream to erode the sides and bottom of the channel should be considered to make sure the stabilization measure will be supported properly. Structures can be designed to protect and improve natural wildlife habitats; for example, log structures and grid pavers can be designed to keep vegetation. Only pressure-treated wood should be used in log structures. Permanent structures should be designed to handle expected flood conditions. A well-designed layer of stone can be used in many ways and in many locations to control erosion and sedimentation. Riprap protects soil from erosion and is often used on steep slopes built with fill materials that are subject to harsh weather or seepage. Riprap can also be used for flow channel liners, inlet and outlet protection at culverts, stream bank protection, and protection of shore lines subject to wave action. It is used where water is turbulent and fast flowing and where soil may erode under the design flow conditions. It is used to expose the water to air as well as to reduce water energy. Riprap and gabion (wire mesh cages filled with rock) are usually placed over a filter blanket (i.e., a gravel layer or filter cloth). Riprap is either a uniform size or graded (different sizes) and is usually applied in an even layer throughout the stream. Reinforced concrete structures may require positive



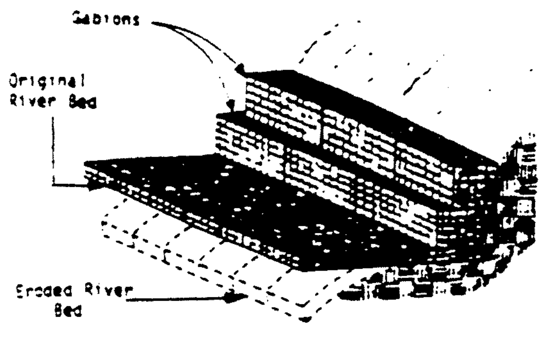
Grid Pavers



Log Cribbing



Riprap



Gabion

FIGURE 4.12 EXAMPLES OF STREAM BANK STABILIZATION PRACTICES
(Modified from Commonwealth of Virginia, 1980, and Commonwealth of Pennsylvania, 1990)

drainage behind the bulkhead or retaining wall to prevent erosion around the structure. Gabion and grid pavers should be installed according to manufacturers' recommendations.

Stream bank stabilization structures should be inspected regularly and after each large storm event. Structures should be maintained as installed. Structural damage should be repaired as soon as possible to prevent further damage or erosion to the stream bank.

Advantages of Stream Bank Stabilization
• Can provide control against erosive forces caused by the increase in storm water flows created during land development • Usually will not require as much maintenance as vegetative erosion controls • May provide wildlife habitats • Forms a dense, flexible, self-healing cover that will adapt well to uneven surfaces (riprap)
Disadvantages of Stream Bank Stabilization
• Does not provide the water quality or aesthetic benefits that vegetative practices could • Should be designed by qualified professional engineers, which may increase project costs • May be expensive (materials costs) • May require additional permits for structure • May alter stream dynamics which cause changes in the channel downstream • May cause negative impacts to wildlife habitats

Mulching, Matting, and Netting

What Are They

Mulching is a temporary soil stabilization or erosion control practice where materials such as grass, hay, woodchips, wood fibers, straw, or gravel are placed on the soil surface. In addition to stabilizing soils, mulching can reduce the speed of storm water runoff over an area. When used together with seeding or planting, mulching can aid in plant growth by holding the seeds, fertilizers, and topsoil in place, by preventing birds from eating seeds, helping to retain moisture, and by insulating against extreme temperatures. Mulch mattings are materials (jute or other wood fibers) that have been formed into sheets of mulch that are more stable than normal mulch. Netting is typically made from jute, other wood fiber, plastic, paper, or cotton and can be used to hold the mulching and matting to the ground. Netting can also be used alone to stabilize soils while the plants are growing; however, it does not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are sometimes used instead of netting to hold loose mulches together.

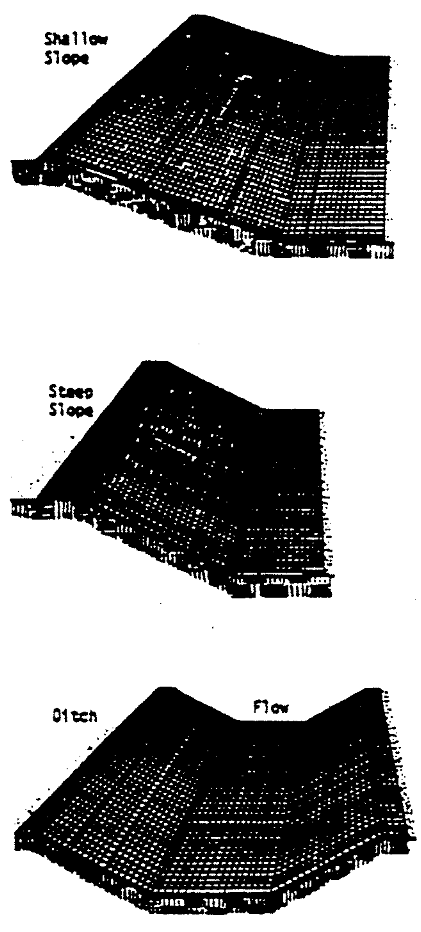


FIGURE 4.13 ORIENTATION OF MULCH NETTING AND MATTING (Modified from County of Fairfax, 1987)

When and Where to Use Them

Mulching is often used alone in areas where temporary seeding cannot be used because of the season or climate. Mulching can provide immediate, effective, and inexpensive erosion control. On steep slopes and critical areas such as waterways, mulch matting is used with netting or anchoring to hold it in place.

Mulch seeded and planted areas where slopes are steeper than 2:1, where runoff is flowing across the area, or when seedlings need protection from bad weather.

What to Consider

Use of mulch may or may not require a binder, netting, or the tacking of mulch to the ground. Effective netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material. Final grading is not necessary before mulching. Mulched areas should be inspected often to find where mulched material has been loosened or removed. Such areas should be reseeded (if necessary) and the mulch cover replaced immediately. Mulch binders should be applied at rates recommended by the manufacturer or, if asphalt is used, at rates of approximately 480 gallons per acre (Arapahoe County, 1988).

Advantages of Mulching, Matting, and Netting
• Provide immediate protection to soils that are exposed and that are subject to heavy erosion • Retain moisture, which may minimize the need for watering • Require no removal because of natural deterioration of mulching and matting
Disadvantages of Mulching, Matting, and Netting
• May delay germination of some seeds because cover reduces the soil surface temperature • Netting should be removed after usefulness is finished, then landfilled or composted

Temporary Seeding

What Is It

Temporary seeding means growing a short-term vegetative cover (plants) on disturbed site areas that may be in danger of erosion. The purpose of temporary seeding is to reduce erosion and sedimentation by stabilizing disturbed areas that will not be stabilized for long periods of time or where permanent plant growth is not necessary or appropriate. This practice uses fast-growing grasses whose root systems hold down the soils so that they are less apt to be carried offsite by storm water runoff or wind. Temporary seeding also reduces the problems associated with mud and dust from bare soil surfaces during construction.

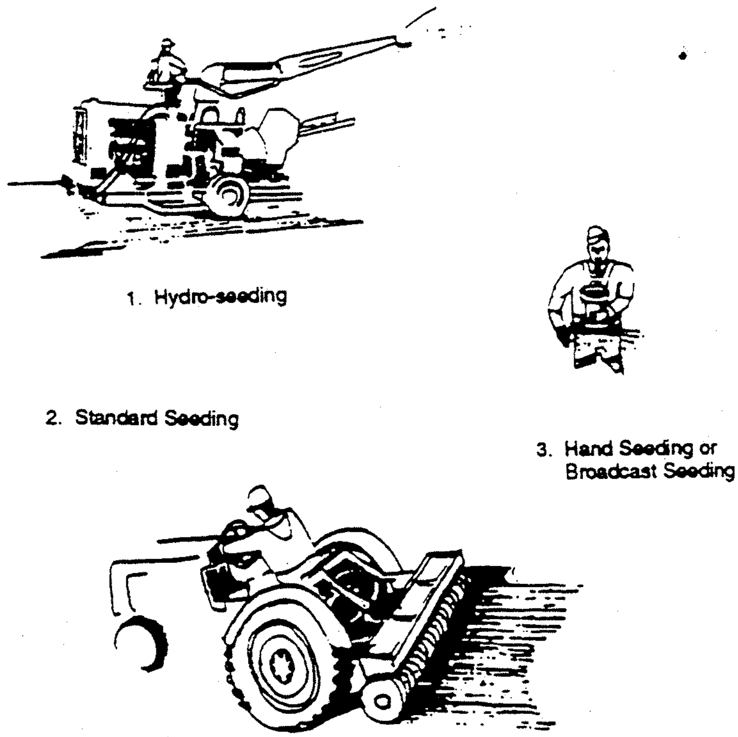


FIGURE 4.14 SEEDING PRACTICES
(Modified from Washington State, 1992)

When and Where to Use It

Temporary seeding should be performed on areas which have been disturbed by construction and which are likely to be redisturbed, but not for several weeks or more. Typical areas might include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins, and temporary roadbanks. Temporary seeding should take place as soon as practicable after the last land disturbing activity in an area. Check the requirements of your permit for the maximum amount of time allowed between the last disturbance of an area and temporary stabilization. Temporary seeding may not be an effective practice in arid and semi-arid regions where the climate prevents fast plant growth, particularly during the dry seasons. In those areas, mulching or chemical stabilization may be better for the short-term (see sections on Mulching, Geotextiles, and Chemical Stabilization).

What to Consider

Proper seed bed preparation and the use of high-quality seed are needed to grow plants for effective erosion control. Soil that has been compacted by heavy traffic or machinery may need to be loosened. Successful growth usually requires that the soil be tilled before the seed is applied. Topsoiling is not necessary for temporary seeding; however, it may improve the chances of establishing temporary vegetation in an area. Seed bed preparation may also require applying fertilizer and/or lime to the soil to make conditions more suitable for plant growth. Proper fertilizer, seeding mixtures, and seeding rates vary depending on the location of the site, soil types, slopes, and season. Local suppliers, State and local regulatory agencies, and the USDA Soil Conservation Service will supply information on the best seed mixes and soil conditioning methods.

Seeded areas should be covered with mulch to provide protection from the weather. Seeding on slopes of 2:1 or more, in adverse soil conditions, during excessively hot or dry weather, or where heavy rain is expected should be followed by spreading mulch (see section on Mulching). Frequent inspections are necessary to check that conditions for growth are good. If the plants do not grow quickly or thick enough to prevent erosion, the area should be reseeded as soon as possible. Seeded areas should be kept adequately moist. If normal rainfall will not be enough, mulching, matting, and controlled watering should be done. If seeded areas are watered, watering rates should be watched so that over-irrigation (which can cause erosion itself) does not occur.

Advantages of Temporary Seeding
• Is generally inexpensive and easy to do
• Establishes plant cover fast when conditions are good
• Stabilizes soils well, is aesthetic, and can provide sedimentation controls for other site areas
• May help reduce costs of maintenance on other erosion controls (e.g., sediment basins may need to be cleaned out less often)
Disadvantages of Temporary Seeding
• Depends heavily on the season and rainfall rate for success
• May require extensive fertilizing of plants grown on some soils, which can cause problems with local water quality
• Requires protection from heavy use, once seeded
• May produce vegetation that requires irrigation and maintenance

Permanent Seeding and Planting

What Is It

Permanent seeding of grass and planting trees and brush provides stabilization to the soil by holding soil particles in place. Vegetation reduces sediments and runoff to downstream areas by slowing the velocity of runoff and permitting greater infiltration of the runoff. Vegetation also filters sediments, helps the soil absorb water, improves wildlife habitats, and enhances the aesthetics of a site.

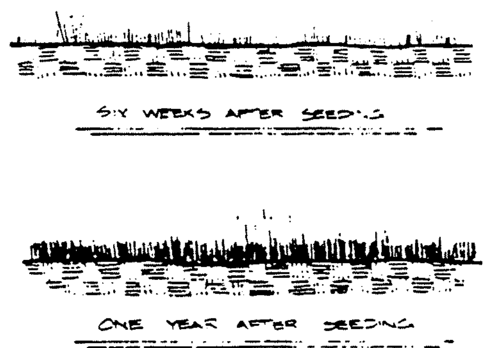


FIGURE 4.15 ESTABLISHING PERMANENT COVER WITH VEGETATION
(Modified from State of North Carolina, 1988)

When and Where to Use It

Permanent seeding and planting is appropriate for any graded or cleared area where long-lived plant cover is desired. Some areas where permanent seeding is especially important are filter strips, buffer areas, vegetated swales, steep slopes, and stream banks. This practice is effective on areas where soils are unstable because of their texture, structure, a high water table, high winds, or high slope. When seeding in northern areas during fall or winter, cover the area with mulch to provide a protective barrier against cold weather (see Mulching). Seeding should also be mulched if the seeded area slopes 4:1 or more, if soil is sandy or clayey, or if weather is excessively hot or dry. Plant when conditions are most favorable for growth. When possible, use low-maintenance local plant species. Install all other erosion control practices such as dikes, basins, and surface runoff control measures before planting.

What to Consider

For this practice to work, it is important to select appropriate vegetation, prepare a good seedbed, properly time planting, and water and fertilize. Planting local plants during their regular growing season will increase the chances for success and may lessen the need for watering. Check seeded areas frequently for proper watering and growth conditions.

Topsoil should be used on areas where topsoils have been removed, where the soils are dense or impermeable, or where mulching and fertilizers alone cannot improve soil quality. Topsoiling should be coordinated with the seeding and planting practices and should not be planned while the ground is frozen or too wet. Topsoil layers should be at least 2 inches deep (or similar to the existing topsoil depth).

To minimize erosion and sedimentation, remove as little existing topsoil as possible. All site controls should be in place before the topsoil is removed. If topsoils are brought in from another site, it is important that its texture is compatible with the subsoils onsite; for example, sandy topsoils are not compatible with clay subsoils.

Stockpiling of topsoils onsite requires good planning so soils will not obstruct other operations. If soil is to be stockpiled, consider using temporary seeding, mulching, or silt fencing to prevent or control erosion. Inspect the stockpiles frequently for erosion. After topsoil has been spread, inspect it regularly, and reseed or replace areas that have eroded.

Advantages of Permanent Seeding and Planting
• Improves the aesthetics of a site • Provides excellent stabilization • Provides filtering of sediments • Provides wildlife habitat • Is relatively inexpensive

Disadvantages of Permanent Seeding and Planting
• May require irrigation to establish vegetation • Depends initially on climate and weather for success

Sodding

What Is It

Sodding stabilizes an area by establishing permanent vegetation, providing erosion and sedimentation controls, and providing areas where storm water can infiltrate the ground.

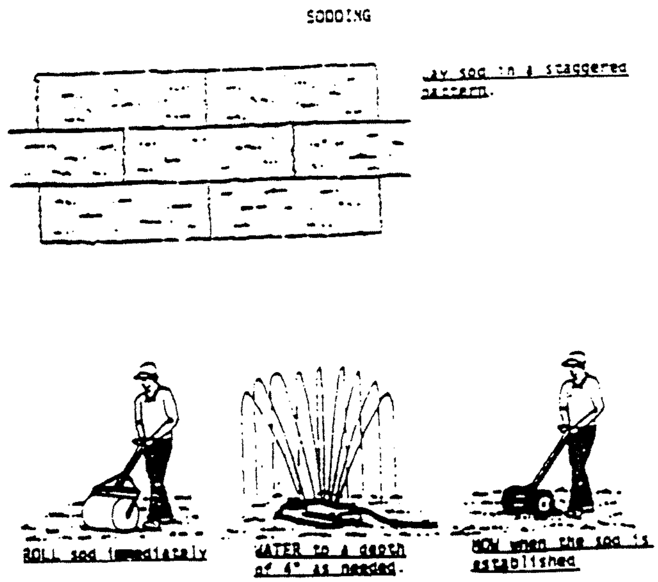


FIGURE 4.16 SODDING
(Modification from County of Fairfax, 1987)

When and Where to Use It

Sodding is appropriate for any graded or cleared area that might erode and where a permanent, long-lived plant cover is needed immediately. Examples of where sodding can be used are buffer zones, stream banks, dikes, swales, slopes, outlets, level spreaders, and filter strips.

What to Consider

The soil surface should be fine-graded before laying down the sod. Topsoil may be needed in areas where the soil textures are inadequate (see topsoil discussion in section on Permanent Seeding and Planting). Lime and fertilizers should be added to the soil to promote good growth conditions. Sodding can be applied in alternating strips or other patterns, or alternate areas can be seeded to reduce expense. Sod should not be planted during very hot or wet weather. Sod should not be placed on slopes that are greater than 3:1 if they are to be mowed. If placed on steep slopes, sod should be laid with staggered joints and/or be pegged. In areas such as steep slopes or next to running waterways, chicken wire, jute, or other netting can be placed over the sod for extra protection against lifting (see Mulching, Matting, and Netting). Rolled or compact immediately after installation to ensure firm contact with the underlying topsoil. Inspect the sod frequently after it is first installed, especially after large storm events, until it is established as permanent cover. Remove and replace dead sod. Watering may be necessary after planting and during periods of intense heat and/or lack of rain.

Advantages of Sodding
• Can provide immediate vegetative cover and erosion control • Provides more stabilizing protection than initial seeding through dense cover formed by sod • Produces lower weed growth than seeded vegetation • Can be used for site activities within a shorter time than can seeded vegetation • Can be placed at any time of the year as long as moisture conditions in the soil are favorable, except when the ground is frozen
Disadvantages of Sodding
• Purchase and installation costs are higher than for seeding • May require continued irrigation if the sod is placed during dry seasons or on sandy soils

Chemical Stabilization

What Is It

Chemical stabilization practices, often referred to as a chemical mulch, soil binder, or soil palliative, are temporary erosion control practices. Materials made of vinyl, asphalt, or rubber are sprayed onto the surface of the soil to hold the soil in place and protect against erosion from storm water runoff and wind. Many of the products used for chemical stabilization are human-made, and many different products are on the market.

When and Where to Use It

Chemical stabilization can be used as an alternative in areas where temporary seeding practices cannot be used because of the season or climate. It can provide immediate, effective, and inexpensive erosion control anywhere erosion is occurring on a site.

What to Consider

The application rates and procedures recommended by the manufacturer of a chemical stabilization product should be followed as closely as possible to prevent the products from forming ponds and from creating large areas where moisture cannot get through.

Advantages of Chemical Stabilization
• Is easily applied to the surface of the soil • Is effective in stabilizing areas where plants will not grow • Provides immediate protection to soils that are in danger of erosion
Disadvantages of Chemical Stabilization
• Can create impervious surfaces (where water cannot get through), which may in turn increase the amount and speed of storm water runoff • May cause harmful effects on water quality if not used correctly • Is usually more expensive than vegetative cover

4.5.2 Structural Erosion Prevention and Sediment Control Practices

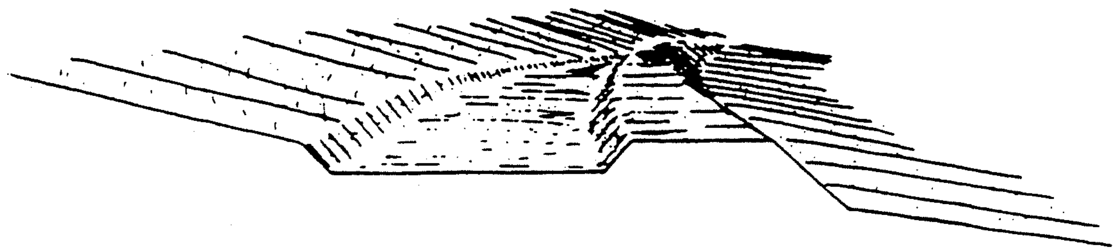
Structural practices used in sediment and erosion control divert storm water flows away from exposed areas, convey runoff, prevent sediments from moving offsite, and can also reduce the erosive forces of runoff waters. The controls can either be used as permanent or temporary measures. Practices discussed include the following:

- Interceptor Dikes and Swales
- Pipe Slope Drains
- Subsurface Drains
- Filter Fence
- Straw Bale Barrier
- Brush Barrier
- Gravel or Stone Filter Berm
- Storm Drain Inlet Protection
- Sediment Trap
- Temporary Sediment Basin
- Outlet Protection
- Check Dams
- Surface Roughening
- Gradient Terraces.

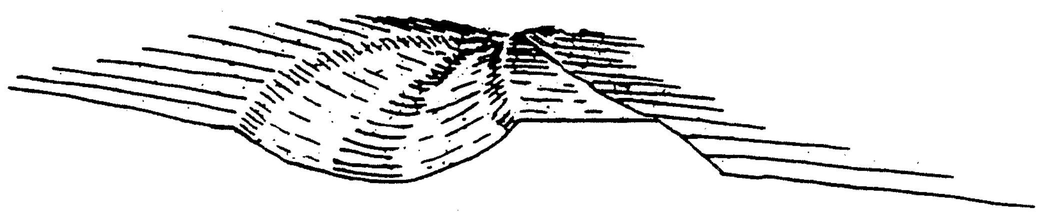
Interceptor Dikes and Swales

What Are They

Interceptor dikes (ridges of compacted soil) and swales (excavated depressions) are used to keep upslope runoff from crossing areas where there is a high risk of erosion. They reduce the amount and speed of flow and then guide it to a stabilized outfall (point of discharge) (see section on Outlet Protection) or sediment trapping area (see sections on Level Spreaders, Vegetated Filter Strips, Sediment Traps, and Temporary Sediment Basins). Interceptor dikes and swales divert runoff using a combination of earth dike and vegetated swale. Runoff is channeled away from locations where there is a high risk of erosion by placing a diversion dike or swale at the top of a sloping disturbed area. Dikes and swales also collect overland flow, changing it into concentrated flows (i.e., flows that are combined). Interceptor dikes and swales can be either temporary or permanent storm water control structures.



TRAPEZOIDAL CROSS-SECTION



PARABOLIC CROSS-SECTION

FIGURE 4.17 TYPICAL INTERCEPTOR DIKES AND SWALES
(Modified from State of Maryland, 1983)

When and Where to Use Them

Interceptor dikes and swales are generally built around the perimeter of a construction site before any major soil disturbing activity takes place. Temporary dikes or swales may also be used to protect existing buildings; areas, such as stockpiles; or other small areas that have not yet been fully stabilized. When constructed along the upslope perimeter of a disturbed or high-risk area (though not necessarily all the way around it), dikes or swales prevent runoff from uphill areas from crossing the unprotected slope. Temporary dikes or swales constructed on the down slope side of the disturbed or high-risk area will prevent runoff that contains sediment from leaving the site before sediment is removed. For short slopes, a dike or swale at the top of the slope reduces the amount of runoff reaching the disturbed area. For longer slopes, several dikes or swales are placed across the slope at intervals. This practice reduces the amount of runoff that accumulates on the face of the slope and carries the runoff safely down the slope. In all cases, runoff is guided to a sediment trapping area or a stabilized outfall before release.

What to Consider

Temporary dikes and swales are used in areas of overland flow; if they remain in place longer than 15 days, they should be stabilized. Runoff channeled by a dike or swale should be directed to an adequate sediment trapping area or stabilized outfall. Care should be taken to provide enough slope for drainage but not too much slope to cause erosion due to high runoff flow speed. Temporary interceptor dikes and swales may remain in place as long as 12 to 18 months (with proper stabilization) or be rebuilt at the end of each day's activities. Dikes or swales should remain in place until the area they were built to protect is permanently stabilized. Interceptor dikes and swales can be permanent controls. However, permanent controls: should be designed to handle runoff after construction is complete; should be permanently stabilized; and should be inspected and maintained on a regular basis. Temporary and permanent control measures should be inspected once each week on a regular schedule and after every storm. Repairs necessary to the dike and flow channel should be made promptly.

Advantages of Interceptor Dikes and Swales
• Are simple and effective for channeling runoff away from areas subject to erosion • Can handle flows from large drainage areas • Are inexpensive because they use materials and equipment normally found onsite
Disadvantages of Interceptor Dikes and Swales
• If constructed improperly, can cause erosion and sediment transport since flows are concentrated • May cause problems to vegetation growth if water flow is too fast • Require additional maintenance, inspections, and repairs

Pipe Slope Drains

What Are They

Pipe slope drains reduce the risk of erosion by discharging runoff to stabilized areas. Made of flexible or rigid pipe, they carry concentrated runoff from the top to the bottom of a slope that has already been damaged by erosion or is at high risk for erosion. They are also used to drain saturated slopes that have the potential for soil slides. Pipe slope drains can be either temporary or permanent depending on the method of installation and material used.

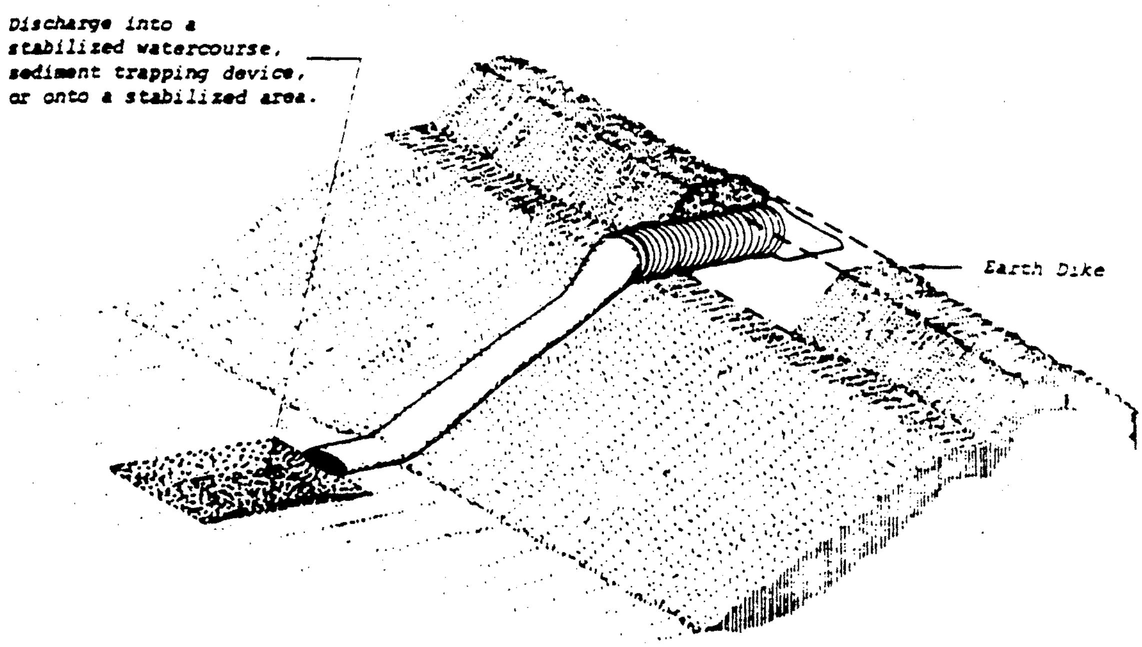


FIGURE 4.18 FLEXIBLE PIPE SLOPE DRAIN (Modified from State of Maryland, 1983)

When and Where to Use Them

Pipe slope drains are used whenever it is necessary to convey water down a slope without causing erosion. They are especially effective before a slope has been stabilized or before permanent drainage structures are ready for use. Pipe slope drains may be used with other devices, including diversion dikes or swales, sediment traps, and level spreaders (used to spread out storm water runoff uniformly over the surface of the ground). Temporary pipe slope drains, usually flexible tubing or conduit, may be installed prior to the construction of permanent drainage structures. Permanent slope drains may be placed on or beneath the ground surface; pipes, sectional downdrains, paved chutes, or clay tiles may be used.

Paved chutes may be covered with a surface of concrete or other impenetrable material. Subsurface drains can be constructed of concrete, PVC, clay tile, corrugated metal, or other permanent material.

What to Consider

The drain design should be able to handle the volume of flow. The effective life span of a temporary pipe slope drain is up to 30 days after permanent stabilization has been achieved. The maximum recommended drainage area for pipe slope drains is 10 acres (Washington State, 1992).

The inlets and outlets of a pipe slope drain should be stabilized. This means that a flared end section should be used at the entrance of the pipe. The soil around the pipe entrance should be fully compacted. The soil at the discharge end of the pipe should be stabilized with riprap (a combination of large stones, cobbles, and boulders). The riprap should be placed along the bottom of a swale which leads to a sediment trapping structure or another stabilized area.

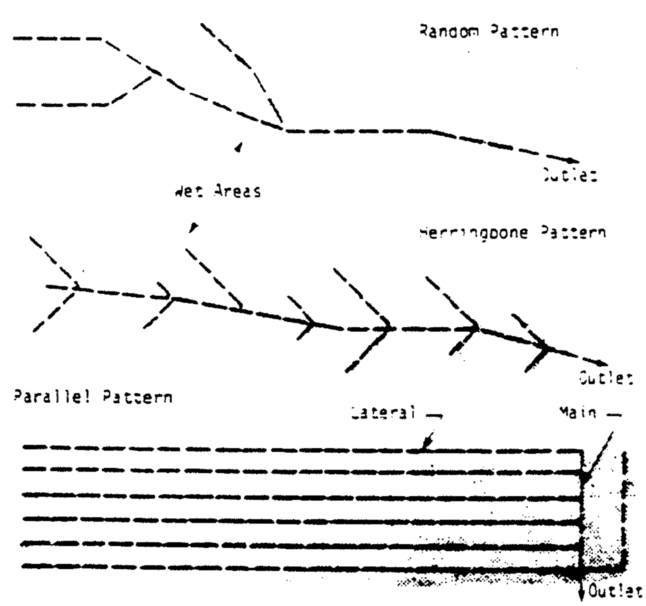
Pipe slope drains should be inspected on a regular schedule and after any major storm. Be sure that the inlet from the pipe is properly installed to prevent bypassing the inlet and undercutting the structure. If necessary, install a headwall, riprap, or sandbags around the inlet. Check the outlet point for erosion and check the pipe for breaks or clogs. Install outlet protection if needed and promptly clear breaks and clogs.

Advantages of Pipe Slope Drains
• Can reduce or eliminate erosion by transporting runoff down steep slopes or by draining saturated soils • Are easy to install and require little maintenance
Disadvantages of Pipe Slope Drains
• Require that the area disturbed by the installation of the drain should be stabilized or it, too, will be subject to erosion • May clog during a large storm

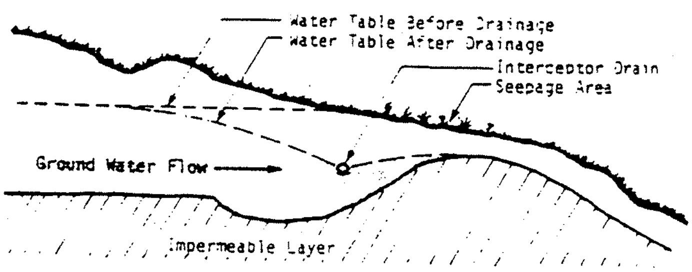
Subsurface Drains

What Are They

A subsurface drain is a perforated pipe or conduit placed beneath the surface of the ground at a designed depth and grade. It is used to drain an area by lowering the water table. A high water table can saturate soils and prevent the growth of certain types of vegetation. Saturated soils on slopes will sometimes "slip" down the hill. Installing subsurface drains can help prevent these problems.



Typical Subsurface Drain Patterns



Effect of Subsurface Drains on Water Table

FIGURE 4.19 SUBSURFACE DRAINS
(Modified from Commonwealth of Virginia, 1980)

When and Where to Use Them

There are two types of subsurface drains: relief drains and interceptor drains. Relief drains are used to dewater an area where the water table is high. They may be placed in a gridiron, herringbone, or random pattern. Interceptor drains are used to remove water where sloping soils are excessively wet or subject to slippage. They are usually placed as single pipes instead of in patterns. Generally, subsurface drains are suitable only in areas where the soil is deep enough for proper installation. They are not recommended where they pass under heavy vehicle crossings.

What to Consider

Drains should be placed so that tree roots will not interfere with drainage pipes. The drain design should be adequate to handle the volume of flow. Areas disturbed by the installation of a drain should be stabilized or they, too, will be subject to erosion. The soil layer must be deep enough to allow proper installation.

Backfill immediately after the pipe is placed. Material used for backfill should be open granular soil that is highly permeable. The outlet should be stabilized and should direct sediment-laden storm water runoff to a sediment trapping structure or another stabilized area.

Inspect subsurface drains on a regular schedule and check for evidence of pipe breaks or clogging by sediment, debris, or tree roots. Remove blockage immediately, replace any broken sections, and restabilize the surface. If the blockage is from tree roots, it may be necessary to relocate the drain. Check inlets and outlets for sediment or debris. Remove and dispose of these materials properly.

Advantages of Subsurface Drains
• Provide an effective method for stabilizing wet sloping soils • Are an effective way to lower the water table
Disadvantages of Subsurface Drains
• May be pierced and clogged by tree roots • Should not be installed under heavy vehicle crossings • Cost more than surface drains because of the expenses of excavation for installation

Filter Fence

What Is It

A silt fence, also called a "filter fence," is a temporary measure for sedimentation control. It usually consists of posts with filter fabric stretched across the posts and sometimes with a wire support fence. The lower edge of the fence is vertically trenched and covered by backfill. A silt fence is used in small drainage areas to detain sediment. These fences are most effective where there is overland flow (runoff that flows over the surface of the ground as a thin, even layer) or in minor swales or drainageways. They prevent sediment from entering receiving waters. Silt fences are also used to catch wind blown sand and to create an anchor for sand dune creation. Aside from the traditional wooden post and filter fabric method, there are several variations of silt fence installation including silt fence which can be purchased with pockets presewn to accept use of steel fence posts.

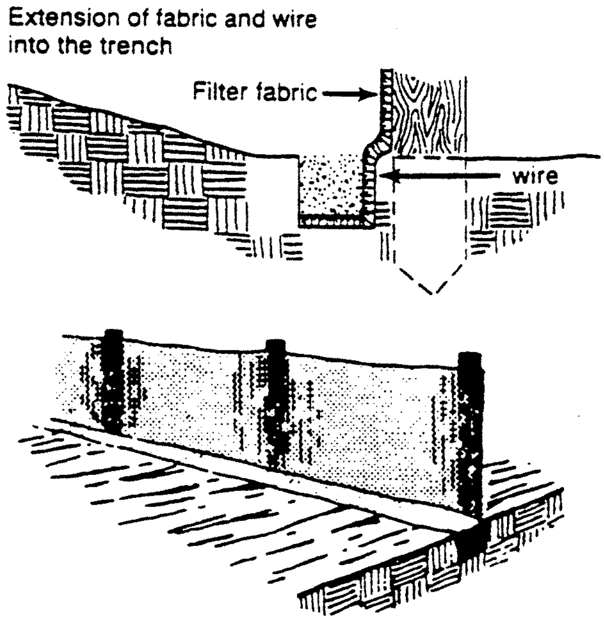


FIGURE 4.20 FILTER FENCE DETAILS
(Modified from State of North Carolina, 1988; and State of Wisconsin, 1988)

When and Where to Use It

A silt fence should be installed prior to major soil disturbance in the drainage area. Such a structure is only appropriate for drainage areas of 1 acre or less with velocities of 0.5 cfs or less (Washington State, 1992). The fence should be placed across the bottom of a slope or minor drainageway along a line of uniform elevation (perpendicular to the direction of flow). It can be used at the outer boundary of the work area. However, the fence does not have to surround the work area completely. In addition, a silt fence is effective where sheet and rill erosion may be a problem. Silt fences should not be constructed in streams or swales.

What to Consider

A silt fence is not appropriate for a large area or where the flow rate is greater than 0.5 cfs. This type of fence can be more effective than a straw bale barrier if properly installed and maintained. It may be used in combination with other erosion and sediment practices.

The effective life span for a silt fence is approximately 6 months. During this period, the fence requires frequent inspection and prompt maintenance to maintain its effectiveness. Inspect the fence after each rainfall. Check for areas where runoff eroded a channel beneath the fence, or where the fence was caused to sag or collapse by runoff flowing over the top. Remove and properly dispose of sediment when it is one-third to one-half the height of the fence or after each storm.

Advantages of a Filter Fence
• Removes sediments and prevents downstream damage from sediment deposits • Reduces the speed of runoff flow • Minimal clearing and grubbing required for installation • Inexpensive
Disadvantages of a Filter Fence
• May result in failure from improper choice of pore size in the filter fabric or improper installation • Should not be used in streams • Is only appropriate for small drainage areas with overland flow • Frequent inspection and maintenance is necessary to ensure effectiveness

Straw Bale Barrier

What Is It

Straw bales can be used as a temporary sediment barrier. They are placed end to end in a shallow excavated trench (with no gaps in between) and staked into place. If properly installed, they can detain sediment and reduce flow velocity from small drainage areas. A straw bale barrier prevents sediment from leaving the site by trapping the sediment in the barrier while allowing the runoff to pass through. It can also be used to decrease the velocity of sheetflow or channel flows of low-to-moderate levels.

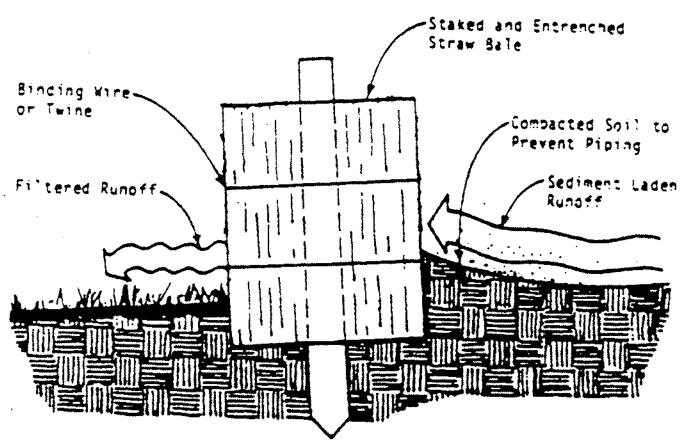


FIGURE 4.21 CROSS SECTION OF A PROPERLY INSTALLED STRAW BALE BARRIER
(Modified from State of Wisconsin, 1988)

When and Where to Use It

A straw bale barrier should be installed prior to major soil disturbance in the drainage area. This type of barrier is placed perpendicular to the flow, across the bottom of a slope or minor drainageway where there is sheetflow. It can be used at the perimeter of the work area, although is does not have to surround it completely. It can also be very effective when used in combination with other erosion and sediment control practices. A straw bale barrier may be used where the length of slope behind the barrier is less than 100 feet and where the slope is less than 2:1.

What to Consider

The success of a straw bale barrier depends on proper installation. The bales must be firmly staked into the entrenchment and the entrenchment must be properly backfilled. To function effectively, the bales must be placed end to end and there can be no gaps between the bales.

Straw bale barriers are useful for approximately 3 months. They must be inspected and repaired immediately after each rainfall or daily if there is prolonged rainfall. Damaged straw bales require immediate replacement. After each storm, or on a regular basis, trapped sediments must be removed and disposed of properly.

Advantages of a Straw Bale Barrier
• Can prevent downstream damage from sediment deposits if properly installed, used, and maintained • Can be an inexpensive way to reduce or prevent erosion
Disadvantages of a Straw Bale Barrier
• May not be used in streams or large swales • Poses a risk of washouts if the barrier is installed improperly or a storm is severe • Has a short life span and a high inspection and maintenance requirement • Is appropriate for only small drainage areas • Is easily subject to misuse and can contribute to sediment problems

Brush Barrier

What Is It

A brush barrier is a temporary sediment barrier constructed from materials resulting from onsite clearing and grubbing. It is usually constructed at the bottom perimeter of the disturbed area. Filter fabric is sometimes used as an anchor over the barrier to increase its filtering efficiency. Brush barriers are used to trap and retain small amounts of sediment by intercepting the flow from small areas of soil disturbance.

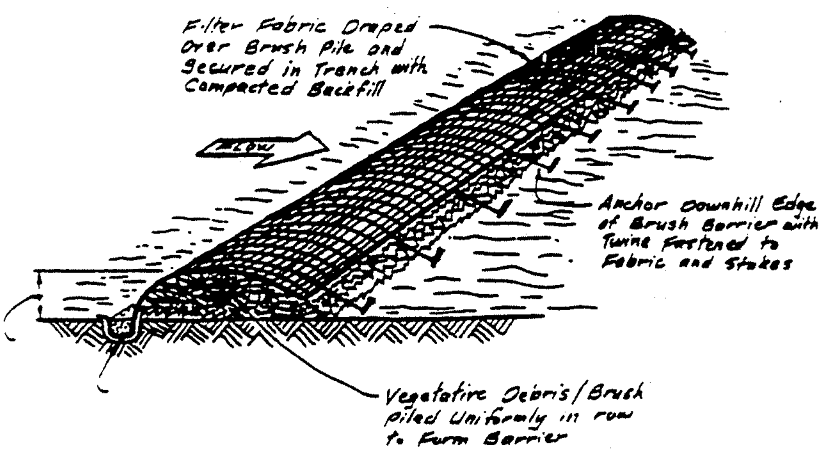


FIGURE 4.22 BRUSH BARRIER
(Modified from Washington State, 1992)

When and Where to Use It

A brush barrier should only be used to trap sediment from runoff which is from a small drainage area. The slope which the brush barrier is placed across should be very gentle. Do not place a brush barrier in a swale or any other channel. Brush barriers should be constructed below areas subject to erosion.

What to Consider

The construction of a brush barrier should be started as soon as clearing and grubbing has produced enough material to make the structure. Wood chips should not be included in the material used for the barrier because of the possibility of leaching. When the site has been stabilized and any excess sediment has been disposed of properly, the filter fabric can be removed. Over time, natural vegetation will establish itself within the barrier, and the barrier itself will decompose.

You will not have to maintain the brush barrier unless there is a very large amount of sediment being deposited. If used, the filter fabric anchor should be checked for tears and the damaged sections replaced promptly. The barrier should be inspected after each rainfall and checked for areas breached by concentrated flow. If necessary, repairs should be made promptly and excess sediment removed and disposed of properly.

Advantages of a Brush Barrier
• Can help prevent downstream damage from sediment deposits • Is constructed of cleared onsite materials and, thus, is inexpensive • Usually requires little maintenance, unless there are very heavy sediment deposits
Disadvantages of a Brush Barrier
• Does not replace a sediment trap or basin • Is appropriate for only small drainage areas • Has very limited sediment retention

Gravel or Stone Filter Berm

What Is It

A gravel or stone filter berm is a temporary ridge constructed of loose gravel, stone, or crushed rock. It slows and filters flow, diverting it from an exposed traffic area. Diversions constructed of compacted soil may be used where there will be little or no construction traffic within the right-of way. They are also used for directing runoff from the right-of-way to a stabilized outlet.

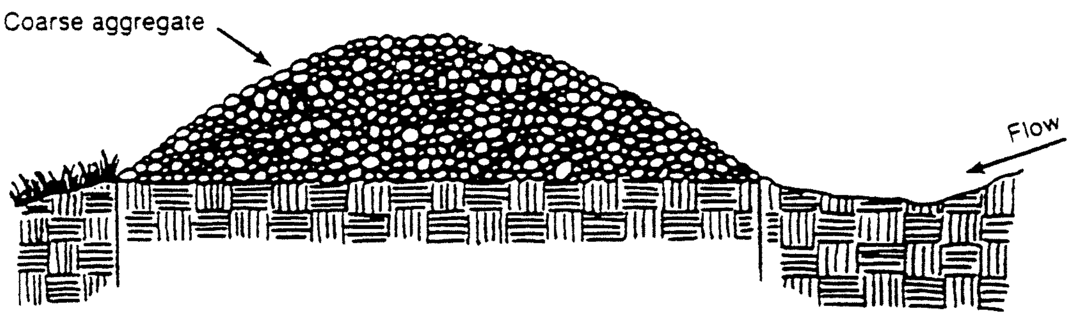


FIGURE 4.23 TYPICAL GRAVEL FILLER BERM
(Modified from Commonwealth of Virginia, 1980)

When and Where to Use It

This method is appropriate where roads and other rights-of-way under construction should accommodate vehicular traffic. Berms are meant for use in areas with shallow slopes. They may also be used at traffic areas within the construction site.

What to Consider

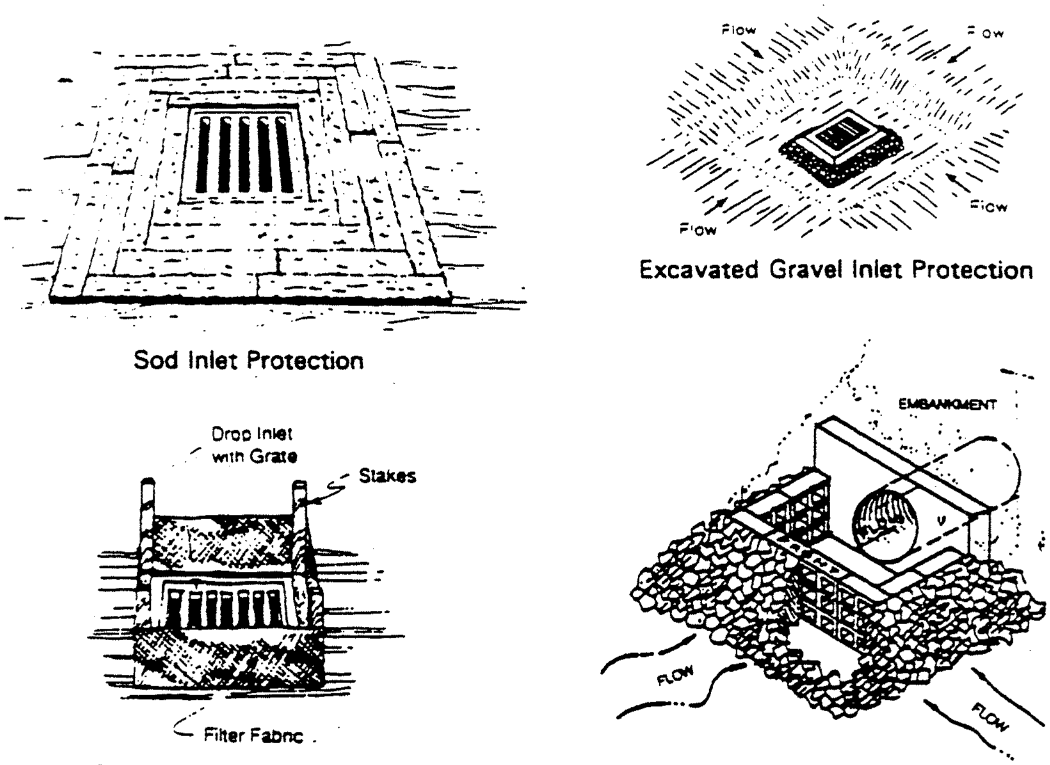
Berm material should be well graded gravel or crushed rock. The spacing of the berms will depend on the steepness of the slope: berms should be placed closer together as the slope increases. The diversion should be inspected daily, after each rainfall, or if breached by construction or other vehicles. All needed repairs should be performed immediately. Accumulated sediment should be removed and properly disposed of and the filter material replaced, as necessary.

Advantages of a Gravel or Stone Filter Berm
• Is a very efficient method of sediment control
Disadvantages of a Gravel or Stone Filter Berm
• Is more expensive than methods that use onsite materials • Has a very limited life span • Can be difficult to maintain because of clogging from mud and soil on vehicle tires

Storm Drain Inlet Protection

What Is It

Storm drain inlet protection is a filtering measure placed around any inlet or drain to trap sediment. This mechanism prevents the sediment from entering inlet structures. Additionally, it serves to prevent the silting-in of inlets, storm drainage systems, or receiving channels. Inlet protection may be composed of gravel and stone with a wire mesh filter, block and gravel, filter fabric, or sod.



Sod Inlet Protection

Excavated Gravel Inlet Protection

Filter Fabric Inlet Protection

Block and Gravel Inlet Protection

FIGURE 4.24 EXAMPLES OF STORM DRAIN INLET PROTECTION

(Modified from State of North Carolina, 1988; Washington State, 1992; and County of Fairfax, 1987)

When and Where to Use It

This type of protection is appropriate for small drainage areas where storm drain inlets will be ready for use before final stabilization. Storm drain inlet protection is also used where a permanent storm drain structure is being constructed onsite. Straw bales are not recommended for this purpose. Filter fabric is used for inlet protection when storm water flows are relatively small with low velocities. This practice cannot be used where inlets are paved because the filter fabric should be staked. Block and gravel filters can be used where velocities are higher. Gravel and mesh filters can be used where flows are higher and subject to disturbance by site traffic. Sod inlet filters are generally used where sediments in the storm water runoff are low.

What to Consider

Storm drain inlet protection is not meant for use in drainage areas exceeding 1 acre or for large concentrated storm water flows. Installation of this measure should take place before any soil disturbance in the drainage area. The type of material used will depend on site conditions and the size of the drainage area. Inlet protection should be used in combination with other measures, such as small impoundments or sediment traps, to provide more effective sediment removal. Inlet protection structures should be inspected regularly, especially after a rainstorm. Repairs and silt removal should be performed as necessary. Storm drain inlet protection structures should be removed only after the disturbed areas are completely stabilized.

Advantages of Storm Drain Inlet Protection
• Prevents clogging of existing storm drainage systems and the siltation of receiving waters
• Reduces the amount of sediment leaving the site
Disadvantages of Storm Drain Inlet Protection
• May be difficult to remove collected sediment
• May cause erosion elsewhere if clogging occurs
• Is practical only for low sediment, low volume flows

Sediment Trap

What Is It

A sediment trap is formed by excavating a pond or by placing an earthen embankment across a low area or drainage swale. An outlet or spillway is constructed using large stones or aggregate to slow the release of runoff. The trap retains the runoff long enough to allow most of the silt to settle out.

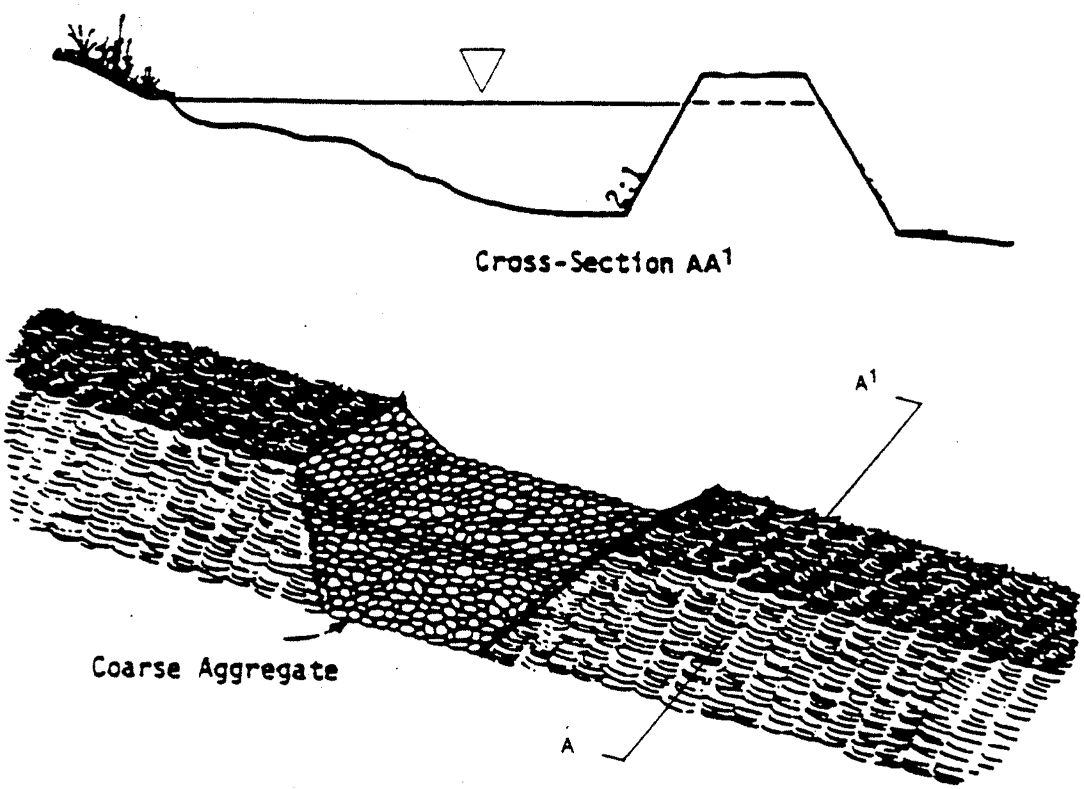


FIGURE 4.25 TYPICAL SEDIMENT TRAP
(Modified from Commonwealth of Virginia, 1980)

When and Where to Use It

A temporary sediment trap may be used in conjunction with other temporary measures, such as gravel construction entrances, vehicle wash areas, slope drains, diversion dikes and swales, or diversion channels. This device is appropriate for sites with short time schedules.

What to Consider

Sediment traps are suitable for small drainage areas, usually no more than 10 acres, that have no unusual drainage features. The trap should be large enough to allow the sediments to settle and should have a capacity to store the collected sediment until it is removed. The volume of storage required depends upon the amount and intensity of expected rainfall and on estimated quantities of sediment in the storm water runoff. Check your Permit to see if it specifies a minimum storage volume for sediment traps.

A sediment trap is effective for approximately 18 months. During this period, the trap should be readily accessible for periodic maintenance and sediment removal. Traps should be inspected after each rainfall and cleaned when no more than half the design volume has been filled with collected sediment. The trap should remain in operation and be properly maintained until the site area is permanently stabilized by vegetation and/or when permanent structures are in place.

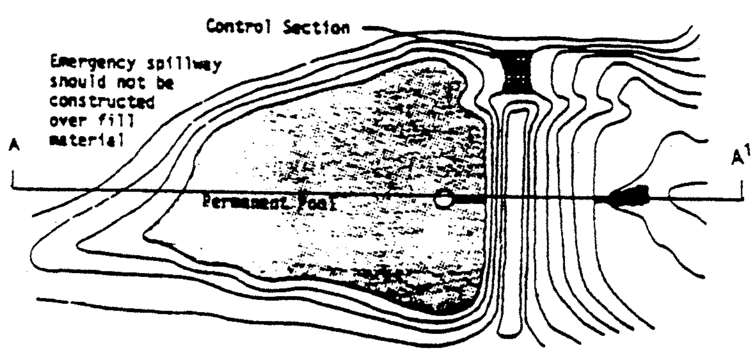
Advantages of a Sediment Trap
• Protects downstream areas from clogging or damage due to sediment deposits • Is inexpensive and simple to install • Can simplify the design process by trapping sediment at specific spots onsite
Disadvantages of a Sediment Trap
• Is suitable only for a limited area • Is effective only if properly maintained • Will not remove very fine silts and clays • Has a short life span

Temporary Sediment Basin

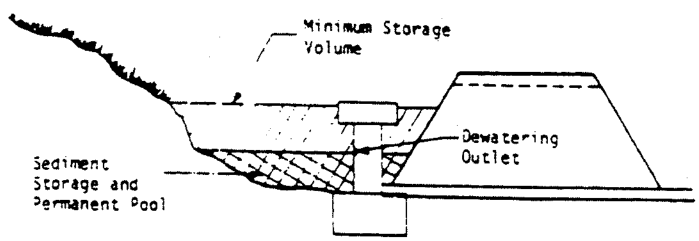
What Is It

A temporary sediment basin is a settling pond with a controlled storm water release structure used to collect and store sediment produced by construction activities. A sediment basin can be constructed by excavation or by placing an earthen embankment across a low area or drainage swale. Sediment basins can be designed to maintain a permanent pool or to drain completely dry. The basin detains sediment-laden runoff from larger drainage areas long enough to allow most of the sediment to settle out.

The pond has a gravel outlet or spillway to slow the release of runoff and provide some sediment filtration. By removing sediment, the basin helps prevent clogging of offsite conveyance systems and sediment-loading of receiving waterways. In this way, the basin helps prevent destruction of waterway habitats.



Plan View



Cross Section AA1

FIGURE 4.26 TEMPORARY SEDIMENT BASIN
(Modified from Commonwealth of Virginia, 1980)

When and Where to Use It

A temporary sediment basin should be installed before clearing and grading is undertaken. It should not be built on an embankment in an active stream. The creation of a dam in such a site may result in the destruction of aquatic habitats. Dam failure can also result in flooding. A temporary sediment basin should be located only where there is sufficient space and appropriate topography. The basin should be made large enough to handle the maximum expected amount of site drainage. Fencing around the basin may be necessary for safety or vandalism reasons.

A temporary sediment basin used in combination with other control measures, such as seeding or mulching, is especially effective for removing sediments.

What to Consider

Temporary sediment basins are usually designed for disturbed areas larger than 5 acres. The pond should be large enough to hold runoff long enough for sediment to settle. Sufficient space should be allowed for collected sediments. Check the requirements of your permit to see if there is a minimum storage requirement for sediment basins. The useful life of a temporary sediment basin is about 12 to 18 months.

Sediment trapping efficiency is improved by providing the maximum surface area possible. Because finer silts may not settle out completely, additional erosion control measures should be used to minimize release of fine silt. Runoff should enter the basin as far from the outlet as possible to provide maximum retention time.

Sediment basins should be readily accessible for maintenance and sediment removal. They should be inspected after each rainfall and be cleaned out when about half the volume has been filled with sediment. The sediment basin should remain in operation and be properly maintained until the site area is permanently stabilized by vegetation and/or when permanent structures are in place. The embankment forming the sedimentation pool should be well compacted and stabilized with vegetation. If the pond is located near a residential area, it is recommended for safety reasons that a sign be posted and that the area be secured by a fence. A well built temporary sediment basin that is large enough to handle the post construction runoff volume may later be converted to use as a permanent storm water management structure.

Advantages of a Temporary Sediment Basin
• Protects downstream areas from clogging or damage due to sediment deposits generated during construction activities • Can trap smaller sediment particles than sediment traps can because of the longer detention time
Disadvantages of a Temporary Sediment Basin
• Is generally suitable for small areas • Requires regular maintenance and cleaning • Will not remove very fine silts and clays unless used in conjunction with other measures • Is a more expensive way to remove sediment than several other methods • Requires careful adherence to safety practices since ponds are attractive to children

Outlet Protection

What Is It

Outlet protection reduces the speed of concentrated storm water flows and therefore it reduces erosion or scouring at storm water outlets and paved channel sections. In addition, outlet protection lowers the potential for downstream erosion. This type of protection can be achieved through a variety of techniques, including stone or riprap, concrete aprons, paved sections and settling basins installed below the storm drain outlet.

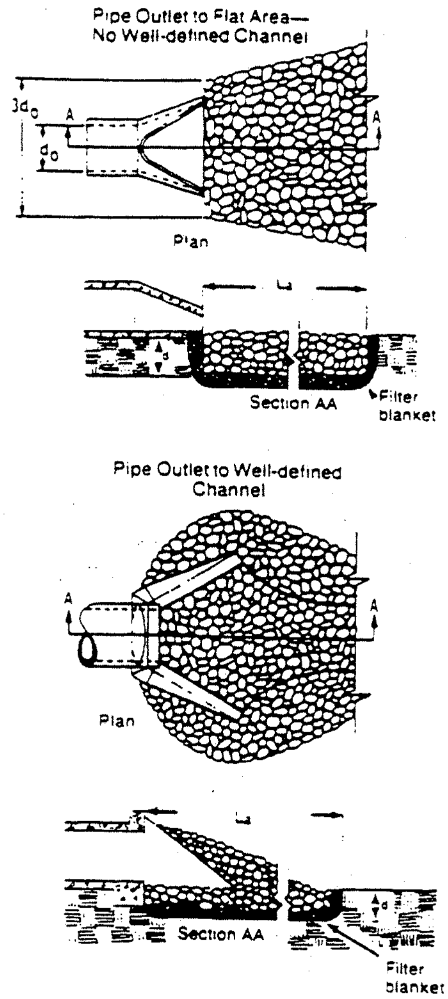


FIGURE 4.27 TYPICAL DETAILS FOR ROCK OUTLET PROTECTION
(Modified from State of North Carolina, 1988)

When and Where to Use It

Outlet protection should be installed at all pipe, interceptor dike, swale, or channel section outlets where the velocity of flow may cause erosion at the pipe outlet and in the receiving channel. Outlet protection should also be used at outlets where the velocity of flow at the design capacity may result in plunge pools (small permanent pools located at the inlet to or the outfall from BMPs). Outlet protection should be installed early during construction activities, but may be added at any time, as necessary.

What to Consider

The exit velocity of the runoff as it leaves the outlet protection structure should be reduced to levels that minimize erosion. Outlet protection should be inspected on a regular schedule to look for erosion and scouring. Repairs should be made promptly.

Advantages of Outlet Protection
• Provides, with riprap-line apron (the most common outlet protection), a relatively low cost method that can be installed easily on most sites • Removes sediment in addition to reducing flow speed • Can be used at most outlets where the flow speed is high • Is an inexpensive but effective measure • Requires less maintenance than many other measures
Disadvantages of Outlet Protection
• May be unsightly • May cause problems in removing sediment (without removing and replacing the outlet protection structure itself) • May require frequent maintenance for rock outlets with high velocity flows

Check Dams

What Are They

A check dam is a small, temporary or permanent dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows. Reduced runoff speed reduces erosion and gullying in the channel and allows sediments and other pollutants to settle out.

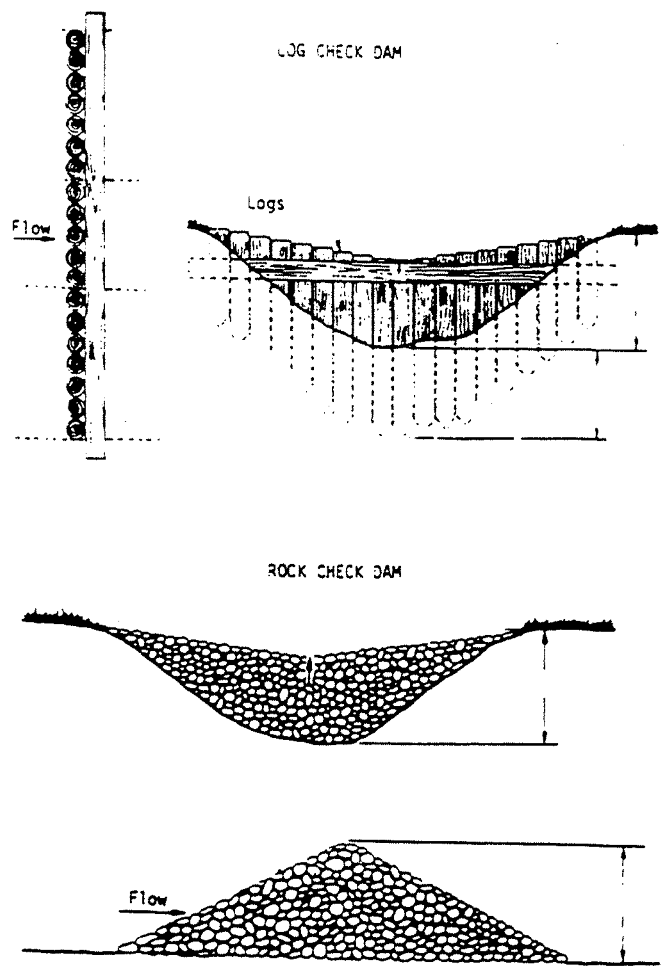


FIGURE 4.28 TYPICAL CHECK DAMS
(Modified from Commonwealth of Virginia, 1980)

When and Where to Use Them

A check dam should be installed in steeply sloped swales, or in swales where adequate vegetation cannot be established. A check dam may be built from logs, stone, or pea gravel-filled sandbags.

What to Consider

Check dams should be used only in small open channels that drain 10 acres or less. The dams should not be placed in streams (unless approved by appropriate State authorities). The center section of the check dam should be lower than the edges. Dams should be spaced so that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

After each significant rainfall, check dams should be inspected for sediment and debris accumulation. Sediment should be removed when it reaches one half the original dam height. Check for erosion at edges and repair promptly as required. After construction is complete, all stone and riprap should be removed if vegetative erosion controls will be used as a permanent erosion control measure. It will be important to know the expected erosion rates and runoff flow rate for the swale in which this measure is to be installed. Contact the State/local storm water program agency or a licensed engineer for assistance in designing this measure.

Advantages of Check Dams
• Are inexpensive and easy to install • May be used permanently if designed properly • Allow a high proportion of sediment in the runoff to settle out • Reduce velocity and provide aeration of the water • May be used where it is not possible to divert the flow or otherwise stabilize the channel
Disadvantages of Check Dams
• May kill grass linings in channels if the water level remains high after it rains or if there is significant sedimentation • Are useful only for drainage areas of 10 acres or less

Surface Roughening

What Is It

Surface roughening is a temporary erosion control practice. The soil surface is roughened by the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land. Slopes that are not fine-graded and that are left in a roughened condition can also control erosion. Surface roughening reduces the speed of runoff, increases infiltration, and traps sediment. Surface roughening also helps establish vegetative cover by reducing runoff velocity and giving seed an opportunity to take hold and grow.

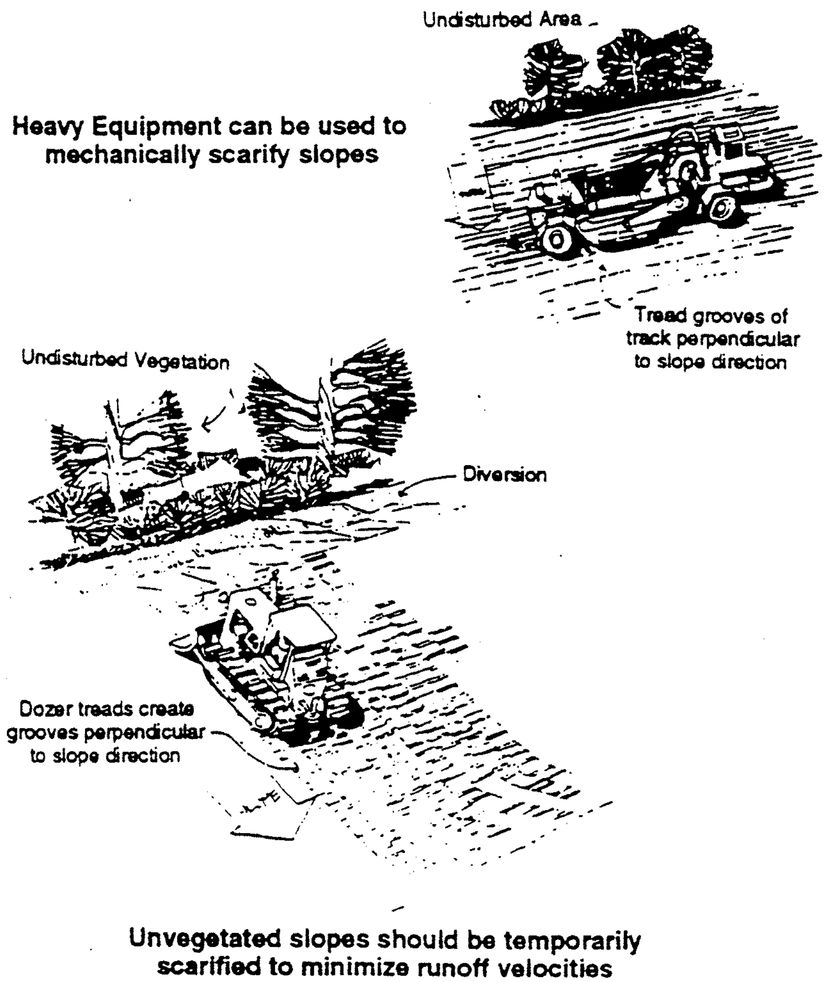


FIGURE 4.29 SURFACE ROUGHENING
(Modified from Washington State, 1992)

When and Where to Use It

Surface roughening is appropriate for all slopes. To slow erosion, roughening should be done as soon as possible after the vegetation has been removed from the slope. Roughening can be used with both seeding and planting and temporary mulching to stabilize an area. For steeper slopes and slopes that will be left roughened for longer periods of time, a combination of surface roughening and vegetation is appropriate.

What to Consider

Different methods can be used to roughen the soil surface on slopes. They include stair-step grading, grooving (using disks, spring harrows, or teeth on a front-end loader), and tracking (driving a crawler tractor up and down a slope, leaving the cleat imprints parallel to the slope contour). The selection of an appropriate method depends on the grade of the slope, mowing requirements after vegetative cover is established, whether the slope was formed by cutting or filling, and type of equipment available.

Cut slopes with a gradient steeper than 3:1 but less than 2:1 should be stair-step graded or groove cut. Stair-step grading works well with soils containing large amounts of small rock. Each step catches material discarded from above and provides a level site where vegetation can grow. Stairs should be wide enough to work with standard earth moving equipment. Grooving can be done by any implement that can be safely operated on the slope, including those described above. Grooves should not be less than 3 inches deep nor more than 15 inches apart. Fill slopes with a gradient steeper than 3:1 but less than 2:1 should be compacted every 9 inches of depth. The face of the slope should consist of loose, uncompacted fill 4 to 6 inches deep that can be left rough or can be grooved as described above, if necessary.

Any cut or filled slope that will be mowed should have a gradient less than 3:1. Such a slope can be roughened with shallow grooves parallel to the slope contour by using normal tilling. Grooves should be close together (less than 10 inches) and not less than 1 inch deep. Any gradient with a slope greater than 2:1 should be stair-stepped.

It is important to avoid excessive compacting of the soil surface, especially when tracking, because soil compaction inhibits vegetation growth and causes higher runoff speed. Therefore, it is best to limit roughening with tracked machinery to sandy soils that do not compact easily and to avoid tracking on clay soils. Surface roughened areas should be seeded as quickly as possible. Also, regular inspections should be made of all surface roughened areas, especially after storms. If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, they should be filled, graded again, and reseeded immediately. Proper dust control procedures should be followed when surface roughening.

Advantages of Surface Roughening
• Provides a degree of instant erosion protection for bare soil while vegetative cover is being established • Is inexpensive and simple for short-term erosion control
Disadvantages of Surface Roughening
• Is of limited effectiveness in anything more than a gentle rain • Is only temporary; if roughening or vegetative cover is washed away in a heavy storm or the vegetation does not take hold, the surface will have to be re-roughened and new seed laid

Gradient Terraces

What Are They

Gradient terraces are earth embankments or ridge-and-channels constructed with suitable spacing and with an appropriate grade. They reduce erosion damage by capturing surface runoff and directing it to a stable outlet at a speed that minimizes erosion.

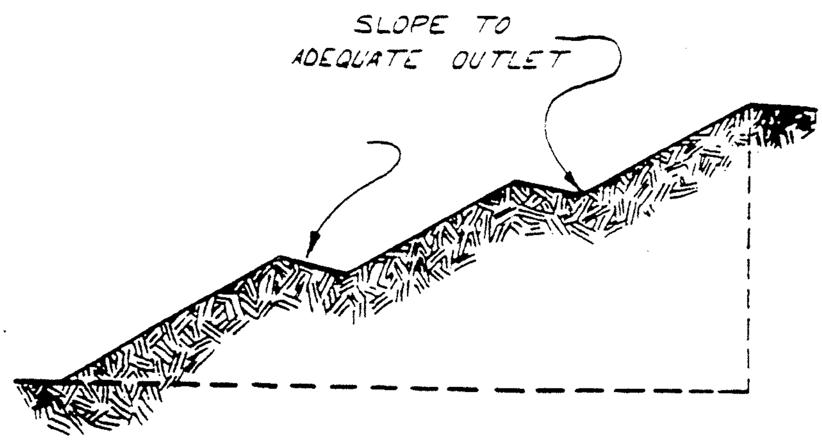


FIGURE 4.30 GRADIENT TERRACE
(Washington State, 1992)

When and Where to Use Them

Gradient terraces are usually limited to use on land that has no vegetation and that has a water erosion problem, or where it is anticipated that water erosion will be a problem. Gradient terraces should not be constructed on slopes with sandy or rocky soils. They will be effective only where suitable runoff outlets are or will be made available.

What to Consider

Gradient terraces should be designed and installed according to a plan determined by an engineering survey and layout. It is important that gradient terraces are designed with adequate outlets, such as a grassed waterway, vegetated area, or tile outlet. In all cases, the outlet should direct the runoff from the terrace system to a point where the outflow will not cause erosion or other damage. Vegetative cover should be used in the outlet where possible. The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow. Terraces should be inspected regularly at least once a year and after major storms. Proper dust control procedures should be followed while constructing these features.

Advantages of Gradient Terraces
• Reduce runoff speed and increase the distance of overland runoff flow • Hold moisture better than do smooth slopes and minimize sediment loading of surface runoff
Disadvantages of Gradient Terraces
• May significantly increase cut and fill costs and cause sloughing if excessive water infiltrates the soil • Are not practical for sandy, steep, or shallow soils

4.6 INFILTRATION PRACTICES

Infiltration practices are surface or subsurface measures that allow for quick infiltration of storm water runoff. Rapid infiltration is possible because the structures or soils used in these practices are very porous. Infiltration practices offer an advantage over other practices in that they provide some treatment of runoff, preserve the natural flow in streams, and recharge ground water. Many of the infiltration practices also can reduce the velocity of the runoff so that it will not cause damaging erosion. Another benefit of infiltration practices is that they reduce the need for expensive storm water conveyance systems. Construction and maintenance of these practices may, however, require some level of expertise to prevent clogging and to retain high effectiveness. The infiltration practices in this section have been divided into two categories: vegetative infiltration practices and infiltration structures.

Infiltration BMPs are not practical in all cases. These practices should not be used in areas where runoff is contaminated with pollutants other than sediment or oil and grease. Excessively drained (i.e., very sandy) soils may provide inadequate treatment of runoff, which could result in ground water contamination. Other site-specific conditions, such as depth to bedrock or depth to the water table, could limit their use or make it impossible to use infiltration BMPs. Also, infiltration practices should not be installed near wells, foundations, septic tank drainfields, or on unstable slopes.

Vegetative infiltration practices rely on vegetated soils that are well drained to provide storage for the infiltration of storm water. Soils used for this practice generally have not previously been disturbed or compacted so that they more easily allow infiltration. Once vegetation has been planted, use of the area must be limited or the practice may not operate efficiently. The practices that are discussed include vegetated filter strips, grassed swales, and level spreaders.

Infiltration structures are built over soils to aid in collection of storm water runoff and are designed to allow storm water to infiltrate into the ground. These structures generally require a level of expertise for both their design and construction so that they function properly. Maintenance activities are very important because infiltration structures are easily damaged by high sediment loads. Often, infiltration structures are used with other structures that pretreat the storm water runoff for sediments, oil, and grease. These pretreatment structures may be as simple as a buffer zone (see Buffer Zones) or may be something more complex, such as an oil and grease separator. The types of infiltration structures discussed include infiltration trenches, porous pavements, concrete grids, and modular pavements.

Vegetated Filter Strips

What Are They

Vegetated filter strips are gently sloping areas of natural vegetation or are graded and artificially planted areas used to provide infiltration, remove sediments and other pollutants, and reduce the flow and velocity of the storm water moving across the terrain. Vegetated filter strips function similarly to vegetated or grassed swales. The filter strips, however, are fairly level and treat sheetflow, whereas grassed swales are indentations (see section on Grassed Swales) and treat concentrated flows. Vegetated filter strips provide permanent storm water control measures on a site.

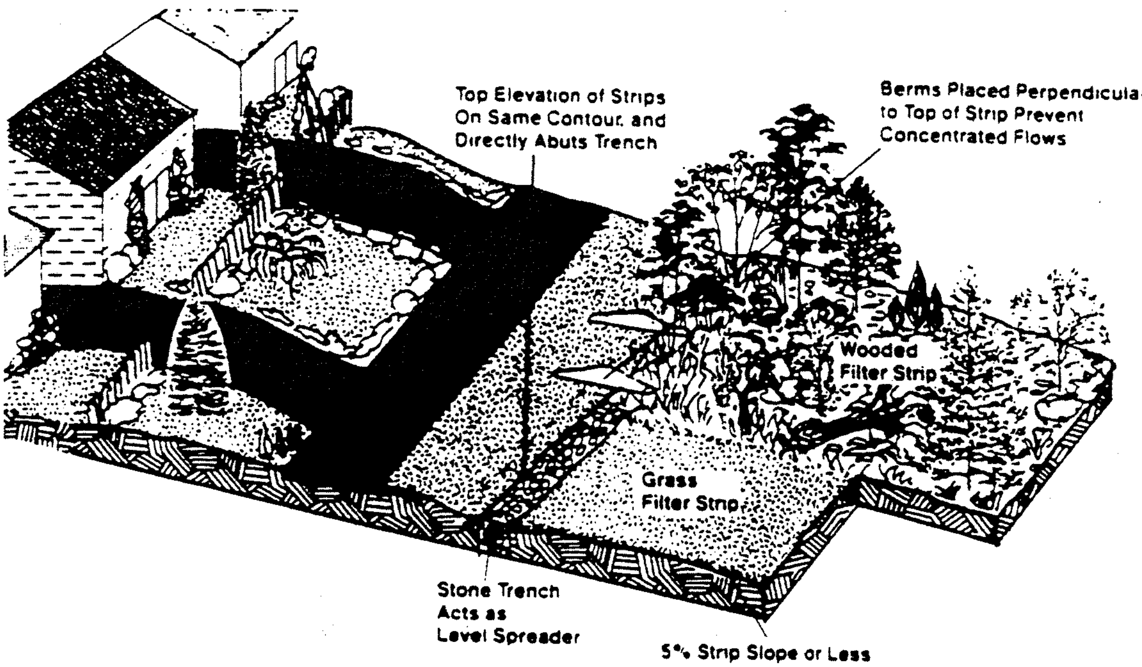


FIGURE 4.31 USE OF FILTER STRIPS (Modified from MWCOG, 1987)

When and Where to Use Them

Vegetated filter strips are suited for areas where the soils are well drained or moderately well drained and where the bedrock and the water table are well below the surface. Vegetated filter strips will not function well on steep slopes, in hilly areas, or in highly paved areas because of the high velocity of runoff. Sites with slopes of 15 percent or more may not be suitable for filtering storm water flows. However, they should still be vegetated (MWCOG, 1987). This practice can be put into place at any time, provided that climatic conditions allow for planting.

What to Consider

At a minimum, a filter strip must be approximately 20 feet wide to function well. The length of the strip should be approximately 50 to 75 feet. Where slopes become steeper, the length of the strip must be increased. Forested strips are always preferred to vegetated strips, and existing vegetation is preferred to planted vegetation. In planning for vegetated strips, consider climatic conditions, since vegetation may not take hold in especially dry and/or cold regions.

Regular inspections are necessary to ensure the proper functioning of the filter strips. Removing sediments and replanting may be necessary on a regular basis. The entire area should be examined for damage due to equipment and vehicles. Vegetation should be dense. Also, the portions of the strip where erosion may have created ponding of runoff should be inspected. This situation can be eliminated by grading.

Advantages of Vegetated Filter Strips
• Provide low to moderate treatment of pollutants in storm water while providing a natural look to a site • Can provide habitat for wildlife • Can screen noise and views if trees or high shrubs are planted on the filter strips • Are easily constructed and implemented • Are inexpensive
Disadvantages of Vegetated Filter Strips
• Are not effective for high velocity flows (large paved areas or steep slopes) • Require significant land space • May have a short useful life due to clogging by sediments and oil and grease

Grassed Swales

What Are They

Grassed swales are vegetated depressions used to transport, filter, and remove sediments. Grassed swales control high runoff rates by reducing the speed of the runoff and by reducing the volume of the runoff through infiltration of the storm water. Pollutants are removed because runoff travels slowly and infiltrates into the soil and because the vegetation in the grassed swale works as a filter or strainer.

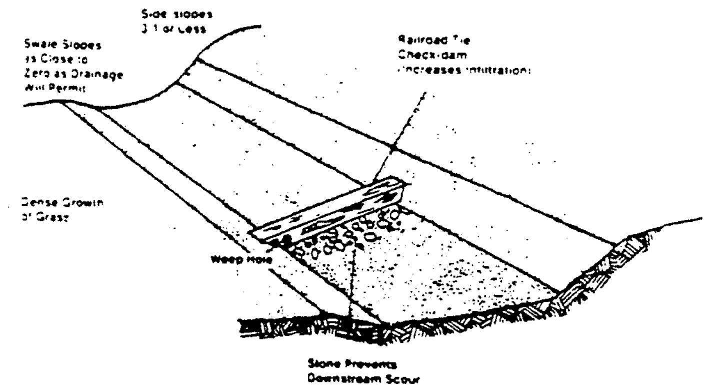


FIGURE 4.32 GRASSED SWALE WITH RAILROAD TIE CHECK DAM (Modified from MWCOG, 1987)

When and Where to Use Them

Grassed swales are suitable for most areas where storm water runoff is low. Certain factors will affect the operation of grassed swales, including soil type, land features, and the depth of the soil from the surface to the water table (i.e., the top of the drenched portion of the soil or bedrock layer). The soil must be permeable for runoff to be able to infiltrate well. Sandy soils will not hold vegetation well nor form a stable channel structure. Steep slopes will increase runoff rates and create greater potential for erosion. Storm water flows will not be easily absorbed where the water table is near the surface. Swales are most useful for sites smaller than 10 acres (MWCOG, 1987). Even without highly permeable soils, swales reduce velocity and thus are useful.

Grassed swales usually do not work well for construction runoff because the runoff has high sediment loads.

What to Consider

The channel of the swale should be as level as possible to maximize infiltration. Side slopes in the swale should be designed to no steeper than 3:1 to minimize channel erosion (MWCOG, 1987). Plans should consider (1) the use of existing topography and existing drainage patterns and (2) the highest flow rate that is expected from a typical storm to determine the most practical size for the swale (in keeping with State or local requirements).

The swale should be tilled before grass is planted, and a dense cover of grasses should be planted in the swale. The location of the swale will determine the best type of vegetation (e.g., if the swale runs next to a road, then the grass chosen should be resistant to the use of de-icing salts in northern states).

Check dams (i.e., earthen or log structures) may be installed in the swales to reduce runoff speed and increase infiltration. Planners should also consider the design of the outlet at the end of the swale so that the runoff is released from the swale at a low rate (see section on Outlet Protection).

Maintenance activities for the swales include those practices needed to maintain healthy, dense vegetation and to retain efficient infiltration and movement of the storm water into and through the swale. Periodic mowing, reseeding, and weed control are required to maintain pollutant removal efficiency. The swale and channel outlet should be kept free from sediment buildup, litter, brush, or fallen tree limbs.

Periodic inspections will identify erosion problems or damaged areas. Damaged or eroded areas of the channel should be repaired. Areas with damaged vegetation should be reseeded immediately.

Advantages of Grassed Swales
• Are easily designed and constructed • Provide moderate removal of sediments if properly constructed and maintained • May provide a wildlife habitat • Are inexpensive • Can replace curb and gutter systems • Can last for long periods of time if well maintained
Disadvantages of Grassed Swales
• Cannot control runoff from very large storms • If they do not drain properly between storms, can encourage nuisance problems such as mosquitos, ragweed, dumping, and erosion • Are not capable of removing significant amounts of soluble nutrients • Cannot treat runoff with high sediment loadings

Level Spreaders

What Are They

Level spreaders are devices used at storm water outlets to spread out collected storm water flows into sheetflow (runoff that flows over ground surface in a thin, even layer). Typically, a level spreader consists of a depression in the soil surface that spreads the flow onto a flat area across a gentle slope. Level spreaders then release the storm water flow onto level areas stabilized by vegetation to reduce speed and increase infiltration.

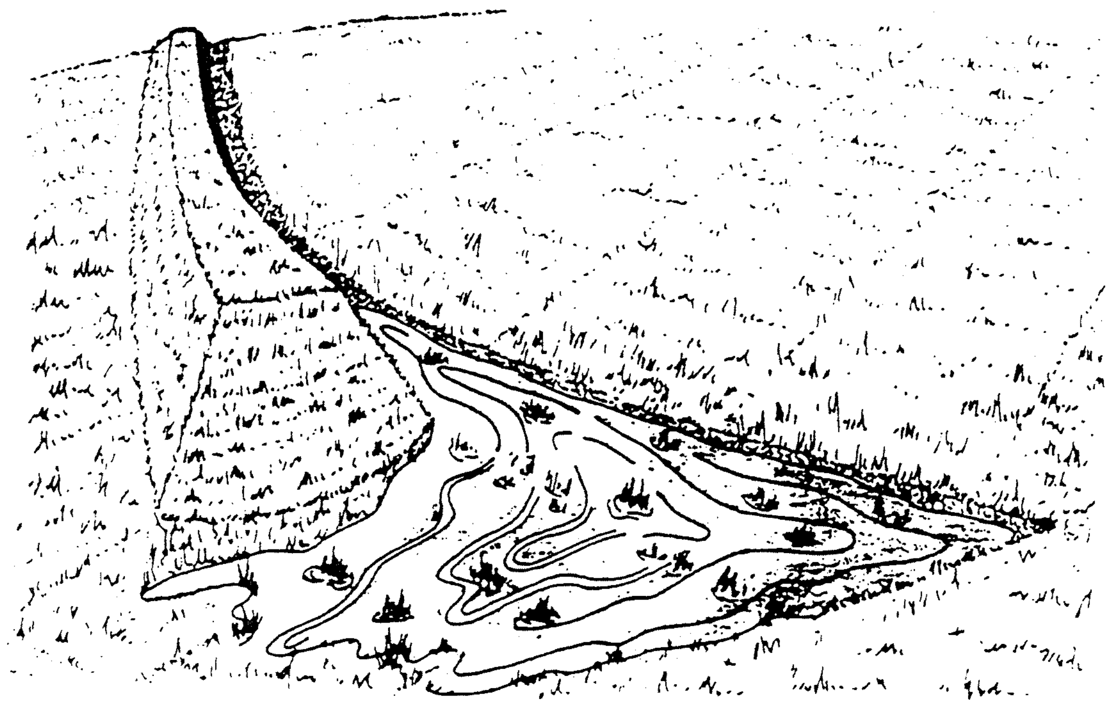


FIGURE 4.33 LEVEL SPREADERS
(Modified from Commonwealth of Virginia, 1990)

When and Where to Use Them

Level spreaders are most often used as an outlet for temporary or permanent storm water conveyances or dikes. Runoff that contains high sediment loads should be treated in a sediment trapping device prior to release into a level spreader.

What to Consider

The length of the spreader depends upon the amount of water that flows through the conveyance. Larger volumes of water need more space to even out. Level spreaders are generally used with filter strips (see Vegetated Filter Strips). The depressions are seeded with vegetation (see Permanent Seeding).

Level spreaders should not be used on soil that might erode easily. They should be constructed on natural soils and not on fill material. The entrance to the spreader should be level so that the flow can spread out evenly.

The spreader should be inspected after every large storm event to check for damage. Heavy equipment and other traffic should be kept off the level spreader because these vehicles may compact the soil or disturb the grade of the slope. If ponding or erosion channels develop, the spreader should be regraded. Dense vegetation should be maintained and damaged areas reseeded as needed.

Advantages of Level Spreaders
• Reduce storm water flow velocity, encourage sedimentation and infiltration • Are relatively inexpensive to install
Disadvantages of Level Spreaders
• Can easily develop "short circuiting" (concentration of flows into small streams instead of sheetflow over the spreader) because of erosion or other disturbance • Cannot handle large quantities of sediment-laden storm water

Infiltration Trenches

What Are They

An infiltration trench usually consists of a long, narrow excavation ranging from 3 to 12 feet deep. The trench is filled with stone, which allows for temporary storage of storm water runoff in the open spaces between the stones. The stored storm water infiltrates into the surrounding soil or drains into underground pipes through holes and is then routed to an outflow point. Infiltration trenches are designed to remove both fine sediments and soluble pollutants rather than larger, coarse pollutants.

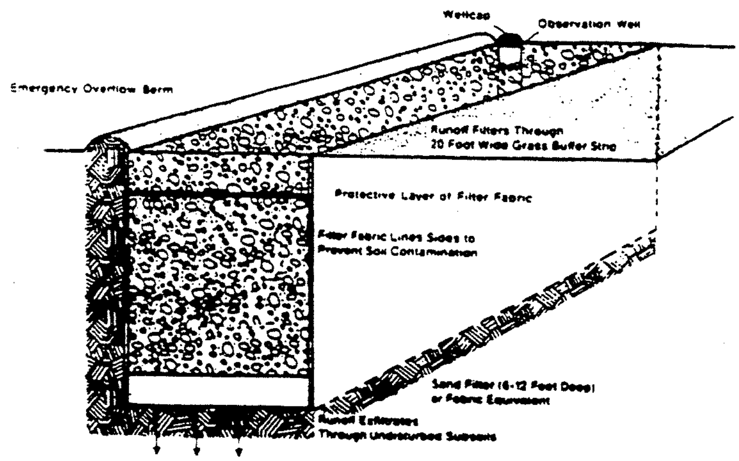


FIGURE 4.34 TYPICAL INFILTRATION TRENCH (Modified from MWCOG, 1987)

When and Where to Use Them

Infiltration trenches should be restricted to areas with certain soil, ground water, slope, area, and pollutant conditions. For example, infiltration trenches will not operate well in soils that have high clay contents, silt/clay soils, sandy/clay loams, or soils that have been compacted. Trenches should not be sited over fill soils because such soils are unstable. Hardened soils are often not suitable for infiltration trenches because these types of soils do not easily absorb water. Infiltration practices in general should not be used to manage contaminated storm water.

The drainage area contributing runoff to a single trench should not exceed 5 acres (State of Maryland, 1983). Construction of trenches should not start until after all land-disturbing activities have ceased so that runoff with high levels of sediment does not fill in the structure.

If slopes draining into the trench are steeper than 5 percent, the runoff will enter the trench too fast and will overwhelm the infiltration capacity of the soil, causing overflow. The depth from the bottom of the trench to the bedrock layer and the seasonal high water table must be at least three feet. Infiltration trenches may not be suitable in areas where there are cold winters and deep frost levels.

What to Consider

Pretreatment of runoff before it is channeled to the trench is important to efficient operation because pretreatment removes sediment, grit, and oil. Reducing the pollutant load in the runoff entering the trench lengthens trench life. One method of pretreatment is to install a buffer zone just above the trench to act as a filter (see Buffer Zones). In addition, a layer of filter fabric 1 foot below the bottom of the trench can be used to trap the sediments that get through the buffer strip. If excavation around the trenches is necessary, the use of light duty equipment will avoid compacting, which could cause a loss of infiltration capability.

Infiltration trenches should be inspected at least once per year and after major rainfall events. Debris should be removed from all areas of the trench, especially the inlets and overflow channels. Dense vegetative growth should be maintained in buffer areas surrounding the trench.

Test wells can be installed in every trench to monitor draining times and provide information on how well the system is operating. Daily test well monitoring is necessary, especially after large storm events. If the trench does not drain after 3 days, it usually means that the trench is clogged.

Advantages of Infiltration Trenches
• Preserve the natural water balance of the site • Are effective for small sites • Remove pollutants effectively
Disadvantages of Infiltration Trenches
• Require high maintenance when sediment loads are heavy • Have short life span, especially if not maintained properly • May be expensive (cost of excavation and fill material)

Porous Pavements/Concrete Grids and Modular Pavements

What Are They

Porous pavement, concrete grids, and modular pavements allow storm water to infiltrate so that the speed and amount of runoff from a site can be reduced.

Porous Pavement–Can be either asphalt or concrete. With porous asphalt pavement, runoff infiltrates through a porous asphalt layer into a stone "reservoir" layer. Storm water runoff filters through the stone reservoir into the underlying subsoil or drains into underground pipes through holes and is routed away. The bottom and sides of the stone reservoir are lined with filter fabric to prevent the movement of soils into the reservoir area.

Porous Concrete Pavement–Is made out of a special concrete mix that has a high number of open spaces between the particles and a coarse surface texture. These open spaces allow runoff to pass through the surface to lower levels. This type of pavement can be placed directly on graded soils. When a subbase is used for stability, 6 inches of sand is placed under the concrete mixture. Up to 6 inches of storm water can be held on the surface of the pavement and within the concrete.

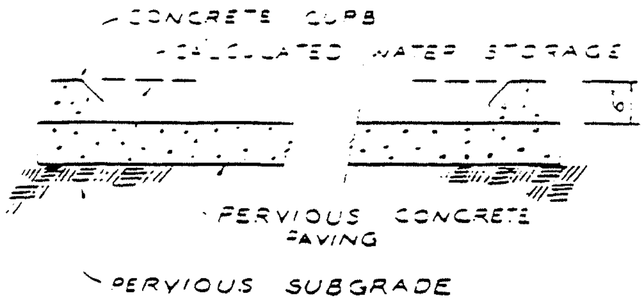
Concrete Grids and Modular Pavement–Are made out of precast concrete, poured-in-place concrete, brick, or granite. These types of pavements can also reduce the loading and concentration of pollutants in the runoff. Concrete grids and modular pavements are designed and/or constructed so that they have open spaces within the pavement through which storm water can infiltrate into the ground. These open spaces can be filled with gravel or sand or have vegetation growing out of them.

When and Where to Use Them

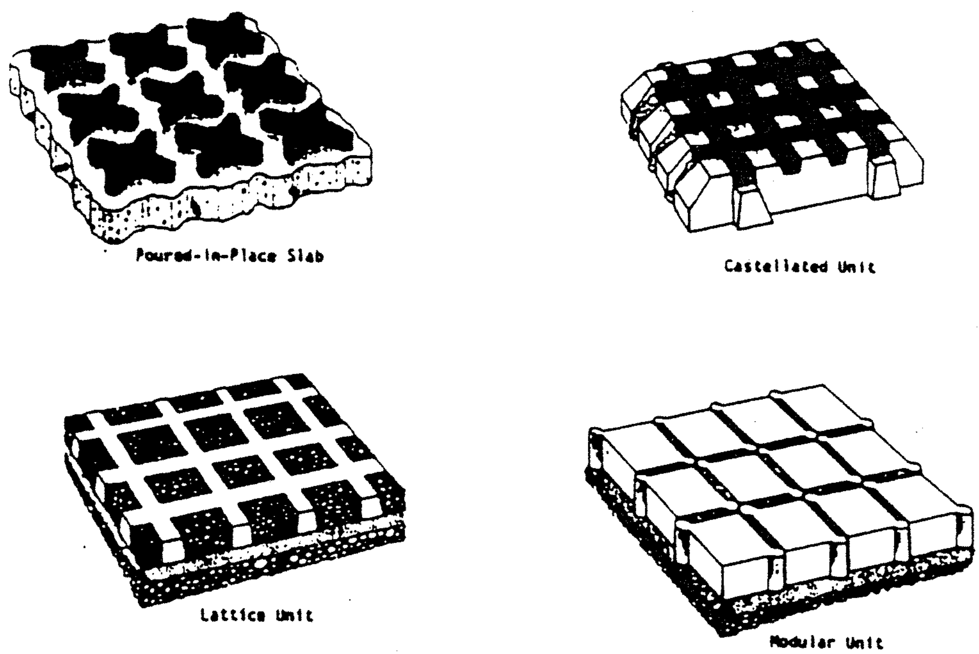
These structures are usually only suitable for low-volume parking areas (1/4 acre to 10 acres) (State of Maryland, 1983) and lightly used access roads. However, areas that are expected to get moderate or high volumes of traffic or heavy equipment can use conventional pavements (for the heavy traffic areas) that are sloped to drain to areas with the porous pavements. These pavements are not effective in drainage areas that receive runoff containing high levels of sediment.

The soil types over which concrete grids and modular pavement are to be placed should allow for rapid drainage through the pores in the pavement. These pavements are not recommended for sites with slopes steeper than 5 percent (MWCOG, 1987) or sites with high water tables, shallow bedrock, fill soils, or localized clay lenses, which are conditions that would limit the ability of the runoff to infiltrate into surface soils. For example, the water table and bedrock should be at least 3 feet below the bottom of the stone reservoir. Porous pavement will not operate well in windy areas where sediment will be deposited on the porous pavement.

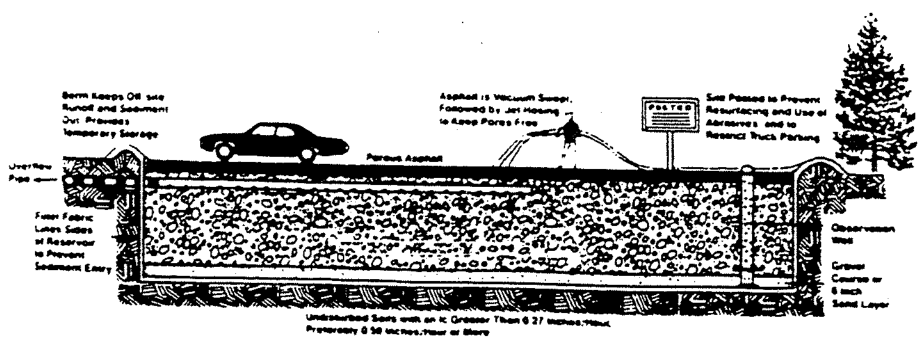
Construction of these pavements should be timed so that installation occurs on the site after other construction activities are finished and the site has been stabilized. Therefore, sediments are less likely to be tracked or carried on to the surface.



Detail of Pervious Concrete Pavement



Types of Grid and Modular Pavements



Cross Section of Porous Asphalt Pavement

FIGURE 4.35 POROUS PAVEMENTS, CONCRETE GRIDS, AND MODULAR PAVEMENTS (Modified from Commonwealth of Virginia, 1980; MWCOG, 1987; and Washington State, 1992)

What to Consider

Proper installation of these pavements requires a high level of construction expertise and workmanship. Only contractors who are familiar with the installation of these pavements should be used.

Designers of porous pavement areas should consider sediment and erosion control. Sediments must kept away from the pavement area because they can clog the pores. Controls to consider for sediments include a diversion berm (i.e., earthen mound) around the edge of the pavement area to block the flow of runoff from certain drainages onto the pavement, or other filtering controls such as silt fences. De-icing salt mixtures, sands, or ash also may clog pores and should not be used for snow removal. Signs should be posted to prohibit these activities.

Since the infiltration of storm water runoff may contaminate ground water sources, these pavements are not suitable for areas close to drinking water wells (at least 100 feet away is recommended) (State of Maryland, 1983).

Maintenance of the surface is very important. For porous pavements, this includes vacuum sweeping at least four times per year followed by high-pressure hosing to reduce the chance of sediments clogging the pores of the top layer. Potholes and cracks can be filled with typical patching mixes unless more than 10 percent of the surface area needs repair. Spot clogging may be fixed by drilling half-inch holes through the porous pavement layer every few feet.

The pavement should be inspected several times the first few months after installation and then annually. Inspections after large storms are necessary to check for pools of water. These pools may indicate clogging. The condition of adjacent vegetated filter strips, silt fences, or diversion dikes should also be inspected.

Concrete grids and modular pavements should be designed in accordance with manufacturers' recommendations. Designers also need information on soils, depth to the water table, and storm water runoff quantity and quality.

Maintenance of concrete grids and modular pavements is similar to that of the porous pavements; however, turf maintenance such as mowing, fertilizing, and irrigation may be needed where vegetation is planted in the open spaces.

Advantages of Porous Pavements/Concrete Grids and Modular Pavements
• Provide erosion control by reducing the speed and quantity of the storm water runoff from the site • Provide some treatment to the water by removing pollutants • Reduce the need for curbing and storm sewer installation and expansion • Improve road safety by providing a rougher surface • Provide some recharge to local aquifers • Are cost effective because they take the place of more expensive and complex treatment systems

Disadvantages of Porous Pavements/Concrete Grids and Modular Pavements
• Can be more expensive than typical pavements • Are easily clogged with sediment and/or oil; however, pretreatment and proper maintenance will prevent this problem • May cause ground water contamination • Are not structurally suited for high-density traffic or heavy equipment • Asphalt pavements may break down if gasoline is spilled on the surface • Are less effective when the subsurface is frozen

APPENDIX B

ACS OFF-SITE AREA SWPPP INSPECTION FORM (BLANK)

ACS OFF-SITE AREA SWPPP INSPECTION FORM

DESCRIPTION	ISSUE DATE	REV #	REV DATE	ISSUED BY
SWPPP INSPECTION FORM	**May 2001**	**-1-**		**SWPPC**

INSPECTOR: ______________________________ **DATE:** ______________________________

BRIEFLY DESCRIBE WEATHER CONDITIONS:

____

____

____

DAYS SINCE LAST RAINFALL: __________ **AMOUNT OF LAST RAINFALL:** ________ **INCHES**

LIST AREAS INSPECTED BELOW:

NOTE EVIDENCE OF EROSION AND/OR SPILLED MATERIALS BELOW:

PAGE	APPROVED BY
1 OF 2	Name (Printed): ______________________________ Signature: ______________________________ Position: ______________________________

ACS OFF-SITE AREA SWPPP INSPECTION FORM

DESCRIPTION	ISSUE DATE	REV #	REV DATE	ISSUED BY
SWPPP INSPECTION FORM	**May 2001**	**-1-**		**SWPPC**

CORRECTIVE ACTION OR MAINTENANCE REQUIRED:

TO BE PERFORMED BY: ______________________________

ON OR BEFORE: ___________________

SIGNATURE OF INSPECTOR: ____

PLEASE NOTE:

IT IS RECOMMENDED THAT A FOLLOW UP INSPECTION BE CONDUCTED AND DOCUMENTED AFTER THE DATE LISTED ABOVE TO CHECK THAT THE CORRECTIVE ACTION/MAINTENANCE HAS BEEN PERFORMED.

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PAGE	APPROVED BY
2 OF 2	Name (Printed): ____________________ Signature: ____________________ Position: ____________________

APPENDIX C

STORM WATER POLLUTION PREVENTION COMMITTEE (SWPPC) CERTIFICATION

CERTIFICATION OF STORMWATER POLLUTION PREVENTION COMMITTEE MEMBERS

ACS Site, Griffith, Indiana

I have read the duties assigned to me on the Pollution Prevention Team Roster and accept those responsibilities. I will perform each task assigned to me to the best of my ability.

Printed Name:	Signed Name:	Date:
LEE OROSZ	Lee Orosz	5-10-01
TOM TINICS	Tom Tinics	7/19/01
PETER J. VAGT, Ph.D., CPG	Peter J Vagt	7/19/01
ROBERT A. ADAMS, P.E.	[illegible]	5/10/01
TRAVIS KLINGFORTH	Travis Klingforth	7/19/01

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POLLUTION PREVENTION TEAM

MEMBER ROSTER

ACS Site, Griffith, Indiana

Leader: Tom Tinics	Title: Project Engineer Office Phone: 219-924-4607
Responsibilities: Be knowledgeable of SWPPP requirements and assure duties are performed	
Team Member 1: Lee Orosz	Title: Site Manager Office Phone: 219-924-4607
Responsibilities: Conduct inspections as required by the SWPPP, direct mantenance of erosion controls, and complete inspection documentation	
Team Member 2: Travis Klingforth	Title: Project Engineer Office Phone: 630-836-8966
Responsibilities: Back-up for inspections and duties of Lee Orosz	
Team Member 3: Robert A. Adams, P.E.	Title: Senior Engineer Office Phone: 630-836-8957
Responsibilities: Quality assurance and plan revisions	
Team Member 4: Peter J. Vagt, PhD., CPG	Title: Project Coordinator Office Phone: 630-836-8923
Responsibilities: Agency notification and coordination	

Form Completed by: Robert A. Adams, P.E.
Title: Senior Engineer
Date: May 4, 2001

APPENDIX D

SWPPP REVISION LOG

ACS OFF-SITE AREA SWPPP

DESCRIPTION	ISSUE DATE	REV #	REV DATE	ISSUED BY
SWPPP REVISION LOG	**May 2001**	**-1-**		**SWPPC**

REVISION DESCRIPTION	REVISION NUMBER	SWPPC MEMBER PRINTED NAME & SIGNATURE

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PAGE	APPROVED BY
1 OF 1	Name (Printed): ______ Signature: ______ Position: ______

APPENDIX E

SPILL RECORD AND CORRECTIVE ACTIONS TAKEN

ACS OFF-SITE AREA SWPPP

DESCRIPTION	ISSUE DATE	REV #	REV DATE	ISSUED BY
SPILL RECORD & CORRECTIVE ACTIONS TAKEN	**May 2001**	**-1-**		**SWPPC**

INSPECTOR: ______________________ **DATE:** ______________________

MATERIAL SPILLED: ______________________ **QUANTITY SPILLED:** ______________________

CIRCUMSTANCES LEADING TO SPILL:

CORRECTIVE ACTIONS TAKEN:

SIGNATURE OF INSPECTOR: ______________________________

APE/RRA

PAGE	APPROVED BY
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APPENDIX F

DETAILS FOR SILT FENCING